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20th Congress, 1st Session. [Doc. No. 216.] Ho. of Reps. War Dept.

JAMES RIVER AND KENHAWA CANAL ROUTE.

LETTER

FROM

THE SECRETARY OF WAR,

[BARBOUR, JAMES]

TRANSMITTING

A REPORT

ON THE

JAMES RIVER AND KENHAWA CANAL ROUTE.

MARCH 24, 1828.

Read, and laid upon the table.

WASHINGTON:

PRINTED BY GALES & SEATON.

1828.

WAR DEPARTMENT,
March 24, 1828.

SIR: In compliance with a resolution of the House of Representatives, of the 2d of January last, I have the honor to transmit, herewith, a letter from the Chief Engineer, of this date, accompanied by a report on the James and Kenhawa Canal Route.

To save time, it has been thought necessary to transmit the original report; which report, it is requested may be returned to this Department, when it shall have answered the purposes of the House.

I have the honor to be,
Very respectfully, sir,
Your most obedient servant,
JAMES BARBOUR.

The Hon. ANDREW STEVENSON,
Speaker of the House of Representatives.

ENGINEER DEPARTMENT,

Washington City, March 24, 1828.

SIR: I have the honor to lay before you a letter from Capt. W. G. McNeill, of the Topographical Engineers, accompanied by his report on the route for a canal between the James and Kenhawa rivers, which report was called for by a resolution of the House of Representatives, of the 2d January last.

I have the honor to be,
Very respectfully,
Your obedient servant,

ALEX. MACOMB,
Maj. Gen. Chief Eng.

Hon. JAMES BARBOUR,
Secretary of War.

GEORGETOWN, D. C.

March 24th, 1828.

SIR: I have the honor to transmit, herewith, a report on the James and Kenhawa Canal; in illustration of which, a map is now in the course of preparation.

All the maps and profiles relating to the experimental surveys are already completed, as well as those exhibiting the locations from the James to the Greenbrier river; the others, including the locations down the Greenbrier and New rivers, are in the progress of completion. There are, in all, nearly *thirty* large maps, including the plans and profiles, on a scale suitable to the exhibition of details; but they are too unwieldly to accompany the report, and are retained till they can be reduced into one general map. Most of the drawings, in relation to the Roanoke and Kenhawa Canal, are nearly finished, but their size renders it necessary that they, also, be reduced into a more convenient shape.

I have the honor to be, sir,
With great respect,
Your obedient servant,

WM. G. McNEILL,
Capt. U. S. Top. Eng.

Maj. Gen. MACOMB, *Chief Eng.*
Washington City.

To Major General Macomb, *Chief Engineer.*

Sir: In pursuance of instructions from the Board of Internal Improvements, of July 29, 1826, predicated on the orders of the Chief Engineer, assigning to my Brigade the execution of certain surveys, "to ascertain the practicability and means of connecting the waters of the Great Kenhawa with those of the James or Roanoke river, by canals or rail roads, or both; and, also, the connection of the Roanoake and James," I have now the honor to

REPORT:

That the short interval which elapsed between the receipt of my instructions and termination of the first season, was consumed in preliminary operations, which merely related to the first object to which my instructions referred, to wit: the practicability of a "connection of the Kenhawa and James rivers, by means of a canal;" that, in May, 1827, the surveys were resumed, and continued till November; and that, in that period, the required location of a line of canal from Covington, on James river, to the foot of the Great Falls of Kenhawa, was effected, with that of all the works relating to a summit level, such as feeders, reservoirs, &c.; and the consequent location made, as enjoined, in the event of its practicability, of a canal from the forks of the Roanoke to the Great Falls of Kenhawa river.

The subject under consideration, naturally advances as our first inquiry, "the *practicability* of a connection of the Kenhawa and James rivers, by means of a canal;" and, in contemplating such a connection, we are led, in the first place, to remark, that the characters of the small tributaries, which empty into the James or Greenbrier river, (the country intermediate to those rivers being that under consideration,) like those of most mountain streams, incontrovertibly prove their inadequacy to the permanent supply of a canal; and that, in consequence, the practicability of the project must depend on the adequacy of the *Greenbrier* river, for that purpose, at some point whence its waters may be conducted to a summit level of such elevation, that the dividing ridge may be passed without encountering an excessive length of tunnel.

To the solution of this question then, various experimental lines were directed through the ravines, which, on the one side, bound the tributaries of Dunlap's creek; and, on the other, through those which, heading opposite to them, define the course of either Second creek, Howard's creek, or Anthony's creek, in their progress to the Greenbrier river; by which, was ascertained the height of the dividing ridge in its greatest depressions, and a profile was carried up Greenbrier river, to obtain such knowledge of its character as was indispensable to the judicious selection of a summit level.

A comparison of the elevation of the dividing ridge, on any route examined, with that of the Greenbrier river, at any point within a reasonable distance, at once discloses the necessity of a tunnel; and that this, with every other fact connected with the subject, may be known, I proceed to detail the results developed in the course of our investigations.

As the basis of comparison, in the description about to be given, all the heights and distances will be referred to the Bench Mark, at the mouth of Dunlap's creek, opposite to the town of Covington,* and to begin with that route, which, from the near approach of the opposite streams, the gradual slope on either side of the dividing ridge, and the seemingly great depression of the Alleghany mountains, might induce a belief of its paramount advantages—we shall describe

1*st.* *A route by the valleys of Dunlap's and Second creeks.*

Dunlap's creek, or its main branch, (known as its South Fork, on which are the famed Sweet Springs,) heads nearly on the summit of the ridge which divides it from Second creek, and pursues its course at the base of Peter's mountain, nearly parallel with the Alleghany mountain, till within six miles of its mouth; when, having received the waters of *Ogley's* creek, it continues, in a direction, in general, nearly at right angles to its former course. Between its source and its confluence with Ogley's creek, several small runs contribute to its supply, such as Cove creek, Fork run, and Brush creek; but they are noticed rather on account of their *directions*, which shall hereafter be alluded to, than because of any efficient aid to be derived from them towards the feeding of a canal.

Dunlap's creek is, in general, bordered by flats, varying in width from 250 yards to half a mile, although it may sometimes occur that the hills impinge so far upon the stream, as to render it preferable to gain an opposite flat by an aqueduct, (since bottom land is always to be found on one side or the other, and the width of the stream never exceeds 35 yards,) than to encounter the obstacles presented by steep side-lying ground, in an attempt to avoid that expense. This remark, however, is applicable, in a degree, as well to all the other valleys, through which experimental lines were run, as to that of Dunlap's creek.

For the first twenty-two miles, the average rise in the stream may be assumed at 25 feet per mile, when, for the next mile, the regularity of its ascent is interrupted by falls and rapids, comprising 135 feet; thence, to the summit, succeeds, first, an ascent for 8 miles, of 73 feet per mile, and, in the remaining half a mile, a rise of 105 feet; making the distance of the summit, from the base mark, 31½ miles, and its elevation 1372 feet 7 inches.

A depression in the Alleghany mountain, west of that just alluded to, induced another experimental line from Dunlap's to Second creek; but of this, suffice it to say, it was found still higher—being 1408 feet above the base mark.

On descending Second creek, the slope from the summit to the Greenbrier river, averages 337 feet per mile, with the exception of the first 2½ miles, in which the fall is 140 feet; or, in other words, the distance from the summit of the mountains to the mouth of Second creek, is 27 miles, and the fall 967 feet; making the total distance from the

* The Bench Mark, at the mouth of Dunlap's creek, is 12 feet below a B. M. established on the opposite side of the river, in 1819, by Messrs. Moore and Briggs, who reported the mouth of Dunlap's creek to be 1238 feet above tide water. Our base mark, therefore, which is about two feet above the water, may be assumed to be 1240 feet above tide water.

mouth of Second creek to that of Dunlap's creek, by their respective valleys, 58½ miles. and the Greenbrier river,* at the mouth of Second creek, 406 feet above the base mark.

Our present purpose, however, being merely, in the first place, to show the relative altitudes of those depressions, which suggested the different experimental lines across the mountain, and to compare them with the elevation of the Greenbrier river, that we may assume a summit level, which may command the waters of the Greenbrier, without involving an impracticable length of tunnel; we shall confine ourselves to the few facts already stated, till, in succession, each route shall have as briefly been considered.

For obvious reasons, which will appear hereafter, (see page 14) no other experimental lines were run from Dunlap's to Second creek, nor was it deemed material, after a careful reconnoissance, that any tributary, above *Fork* run, should be surveyed.

We shall then next describe that, as the

SECOND ROUTE—*by Dunlap's creek, Fork run, and Howard's creek.*

Howard's creek, the first tributary of any note, to the Greenbrier river, above Second creek, at the distance of seven miles from its mouth, is formed by the union of its three branches, which, from their relative directions, we shall designate as the south, the middle, and the north forks.

The *south* fork rises near the heads of the upper branches of Dunlap's and Second creeks, and pursues a course nearly parallel with Dunlap's creek, till it receives the waters of *Tuckahoe* run, a small stream which empties into it near Combs' saw mill.

The first depression, remarkable in the dividing ridge between Dunlap's creek and the south fork of Howard's creek, is found where the Alleghany is indented on the west by Tuckahoe, as it is on the east by Fork run, an opposite tributary to Dunlap's creek; and it is through this depression, that the *second route* is directed.

That part of the route between the mouth of Dunlap's creek and Fork run, has already been described, as ascending at the average rate of 25 feet per mile; thence, to the summit of the mountain, through the narrow valley of Fork run, (sufficiently wide, however, for a canal; the flats usually being from 100 to 200 feet wide,) we ascend at a much more rapid rate, and, in the short distance of 5 miles and thirty-eight yards, rise 689 feet; making the height of the Alleghany, at the head of Fork run, 1092 feet, and its distance from the base mark, 22¾ miles.

The descent on the west, by the ravine of Tuckahoe run, is very precipitous for one mile 593 yards—the fall, in that distance, being 331 feet; when having arrived at the south fork of Howard's creek, the fall becomes quite gradual; the distance from the mouth of Tuckahoe to that of Howard's creek, being 10⅜ miles, and the fall 315 feet.

The valley of Howard's creek, is, in general, wide, and under cultivation, and, with the exception of the short distance of one-eighth of a mile above Hunter's Mill, where the mountains on either side termi-

*Viz: the bench mark at the mouth of Second creek.

nate in the stream, the construction of a canal would encounter no particular difficulty from the nature of the ground.

Fork run, at the distance of 4 miles 750 yards from its mouth, branches in two directions; that which we have heretofore alluded to, being the southern of the two; but, as the Alleghany, where it divides the *northern* branch from the middle fork of Howard's creek, presents another depression, through it was directed the

THIRD ROUTE.—*By Dunlap's creek, Fork run, to the middle fork of Howard's creek, and, thence, by the valley of Howard's creek, to the Greenbrier river.*

Of this route, although among the most promising, since, with the exception of a few miles, it occupies the same ground as the second route, but little need be said. The height of the dividing ridge is greater than by the second; being 1,221 feet—and the access to the summit, on either side, more gradual; it does not, therefore, present as short a tunnel. Indeed, the only advantage which it possesses, arises from its being nearer the Greenbrier river; and it will be shewn, hereafter, how far that can place it in competition.

BRUSH creek, the next tributary to Dunlap's creek, has been enumerated among those whose direction claimed some notice. But since the turnpike road, which pursues the valley of the South Fork of *Ogley's* creek, to its source in the ridge, crosses that ridge, and enters the valley of Brush creek, several miles from the summit of the Alleghany; instead of running a profile from the *mouth* of Brush creek, it was thought sufficient to continue the profile from Ogley's creek in the direction of the turnpike; and, from the point at which it strikes Brush creek, to cross the Alleghany in the three depressions in which the several branches of Brush creek head opposite the *Middle* and the *North* Forks of Howard's creek: for it was apparent, if a tunnel should be requisite by either of the routes from Brush Creek, that its length, unless immoderate, would be included between the intersection of the turnpike with that stream, and its corresponding elevation west of the mountain.

The first line from Brush creek was directed through the gap occupied by the present turnpike road, to the *Middle* Fork of Howard's creek; it determined the height of that gap to be 1,288 feet; by the second line, the height of the depression through which the former road was located, was found to be 1,252 feet; and, by the third line, from Brush creek, the elevation of the Alleghany in a depression between it and the *North* Fork of Howard's creek, was found to be 1,534 feet. It will be seen, on the assumption of a summit level, that, by no route from Brush creek could the passage of the Alleghany be effected by as short a tunnel as will be found on other routes.

Ogley's creek, the last tributary to Dunlap's Creek, of any importance, alone remains to be spoken of. We have already incidentally mentioned, in describing the routes by Brush creek, that its southern fork heads in a ridge between it and Brush creek; but, although the

height of that ridge (it being 1,143 feet above the base mark, and 200 feet above its western base) would, of course, necessitate a longer tunnel from the South Fork of Ogley's creek than from Brush creek, and would, in consequence, oppose itself successfully to the location of a canal; yet, since the shortest route from the James to the Greenbrier river, would be in the direction of the present turnpike road, in reference to the selection of the best route for a *rail road*, (an ulterior object contemplated by my instructions) the valley of the South Fork of Ogley's creek merits more consideration, than if a canal alone were the subject of our investigations.

The valley of Ogley's creek is not, either in the quality of its soil, or the nature of the rocks in its vicinity, particularly distinguished by any peculiar characteristic: for three miles from its mouth, it affords a considerable quantity of rich productive land on the northern side, to which the flats are almost exclusively confined; and, beyond that, as we approach the mountain by its South Fork, we find the valley contracted to a width of but from 50 to 100 yards.

The *Middle* Fork of Ogley's creek, however, is the main branch, and it presents a wider valley throughout its course than that of the South Fork, with which it unites nine miles from the base mark, and 230 feet above it. Its direction corresponds nearly with that of the North Fork of Howard's creek, and is such as to bring it nearer to *Anthony's* creek than any other of the eastern tributaries; which fact rendered its examination the more important, because of the advantages which would result from the proximity of a summit level on Anthony's creek to the source whence the supply of water is to be derived.

A profile was, therefore, continued throughout the whole length of the Middle Fork of Ogley's creek, and thence down Anthony's creek, with the intent to learn, as well if any depression existed between Ogley's and the North Fork of Howard's creek, as the difficulties opposed to the route of a canal in the valley of Anthony's creek. Of the one or two experiments made from the Middle Fork of Ogley's creek to the North Fork of Howard's creek, it is sufficient to state, that, although carried no great distance from the former, they conclusively proved that the height and width of the mountain between those streams, rendered their connection impracticable.

The elevation of the Alleghany, where it divides the Middle Fork of Ogley's from the nearest head branch of Anthony's creek, is 1,772 feet, and the distance to that point from the base mark, 20 miles and 1,100 yards; the descent thence to the B. M. at the mouth of Anthony's creek, (five feet above the stream) was found to be 1,212 feet, and the distance 18½ miles; hence the Greenbrier river, at the mouth of Anthony's creek, is 555 feet above the base mark.

The profile from Ogley's creek to the mouth of Anthony's creek, descended for 1½ miles a mere ravine, which bounds the small tributary known as Laurel run; but thence, to within six miles of the mouth of Anthony's creek, during which, from the accession from tributaries, its supply has become considerable, we, in general, find the stream bordered by fertile bottoms, under cultivation, from one quarter to a half mile in width. Nor is it until it breaks through the Green-

brier mountain, (when the flats disappear) that either its descent is so rapid, or its valley so contracted, as to qualify it advantageously for the purposes of a reservoir.

It is only necessary now to add, that a profile was carried up the *North* Fork of Ogley's creek, till having risen 841 feet above the base mark, we were satisfied of the inutility of proceeding farther; (since its source was known to be as elevated, and more distant from Anthony's creek, than that of the *Middle* Fork) and it will be apparent, from an inspection of the map, that no depression can exist in the ridge dividing the waters of Dunlap's creek from those which flow into the Greenbrier river, which has not been sufficiently examined to enable us to determine the best route for the passage of the Alleghany—abstracting such considerations as relate to the supply of water.

These considerations now suggest, as the subject of our next inquiry, the character of the Greenbrier river, whose relative position to the different routes, or comparative supply at different elevations, is to be so influential in determining the proper elevation for the summit level.

The survey and level of Greenbrier river were commenced at a B. M. at the mouth of Howard's creek, (5,935 feet above the then surface of the water) and continued for thirty-nine miles up the river; in which distance, the ascent was found to be 318 feet, or the point at which we stopped is 770 feet above the base mark.

Anthony's creek and Spring creek are the only tributaries of much consequence intermediate to Howard's creek and the "Droop Mountain," near which latter point the survey of Greenbrier river was discontinued; and, therefore, it was with less surprise we observed that the supply of water did not diminish very materially in our progress up the river; or that, on the contrary, it seemed to vary but little when, *in passing over ledges*, its whole volume could be estimated. For, as an exception to the apparent uniformity of its supply, it is to be remarked that, at times, the stream almost disappears among the loose stones and fissures of its bed; and that, in one case where a vein of limestone traverses its valley, all the water is passed through a subterraneous channel for the distance of a mile nearly. This, however, occurs but once, (in the 23d mile from Howard's creek) and then only in very low stages of the water.

Greenbrier river pursues a very sinuous course through a valley unusually contracted, when viewed with reference to the size of the stream; and, with some partial exceptions only, we find it, throughout the extent at present under consideration, bordered by high and rugged hills, which descend steeply to the water's edge. There are, it is true, narrow strips of alluvial on one or the other side, but they are never continuous for any considerable distance, nor of such value as to merit consideration, when their submersion shall be the consequence of such dams as might be desired for the formation of reservoirs.

The country west of Greenbrier river, although hilly, affords rich and arable land; east of the river it is mountainous, and, in general, but illy adapted to agricultural purposes. But, for a more minute description of the quality of the soil, vegetable and mineral productions, &c. and of the character of the country above Droop Mountain,

resort may be had to the report of Lieut. Dillahunty, which is appended to this report.

A reference to the profile of the river will show that the general and average rise of 7.6 feet per mile, for 31 miles above Howard's creek, is but seldom interrupted; and that, beyond that, or as we approach "Droop Mountain," the average rise of the Greenbrier is about ten feet per mile.

The heights to which freshets rise above the ordinary bed of the stream, vary, of course, with the slope and *width* of the valley. Traces of such as are known to be of frequent occurrence, at almost all seasons of the year, were perceived six and eight feet above low water water mark, and indications were remarked of freshets having, sometimes, attained the height of sixteen feet in the broadest parts of the river. The influence of but comparatively slight rains is very perceptible in the floods which succeed; and from their frequency and the magnitude of the volume which passes at such times, we have ample assurance that the most extensive reservoirs (for the formation of which, the valley of Greenbrier is so admirably adapted) could be replenished as often as might be necessary.

To revert, however, to the relative elevation of the Greenbrier river, and of the Alleghany Mountain, in the different depressions heretofore recited, we readily perceive that the supply from Greenbrier, on which, as was premised, the practicability of the project rests, cannot be commanded within a reasonable distance without resorting to a tunnel: for the greatest depression in the Alleghany Mountain being 1,092.75 feet above the base mark, while the elevation of the Greenbrier river 39 miles above Howard's creek, is but 770.7 feet; at an average rise of ten feet in the Greenbrier, beyond the point to which it was levelled, an elevation, corresponding to that of the most depressed point of the Alleghany, would not be attained in less than 71 miles from the mouth of Howard's creek; and supposing *the spur which projects from the Alleghany, between the waters of Howard's and Anthony's creeks*, sometimes called the "Greenbrier Mountain," (see map of experimental surveys) to be passed without winding around its extremity near the mouth of Howard's creek, the length of a feeder from the summit level could not be much, if any, less, than would be the distance from the mouth of Howard's creek to the assumed elevation of the summit level on the Greenbrier.

Besides, the ruggedness and steepness of the hills bordering the Greenbrier, may be said to be almost in proportion to the elevation above the stream, at which we encountered them; and, on that account, it would be desirable to run the feeder as low as possible. Adding to these considerations, the fears which might reasonably be entertained of the inadequacy of the Greenbrier to supply the losses of so long a feeder as would be required to pass the Alleghany without a tunnel, and the necessity of a tunnel would seem to be obvious.

This conclusion leads us to compare the lengths of tunnels at different elevations; which, limiting the depth of cutting, at which the tunnels are supposed to commence and terminate at thirty-five feet, are now exhibited in the following table.

TABLE.

No. of Route.	DESIGNATION OF ROUTE.	Elevation of the summit level, above the base mark.	Length of cut east of the Alleghany.		Length of cut west of the Alleghany Mountains.		Length of Tunnel.	
		Feet.	Miles.	Yards.	Miles.	Yards.	Miles.	Yards.
1	From Dunlap's creek to Second creek,	750	1	283	0	1,173	10	867
2	Do by Fork run to south fork of Howard's creek,	do	0	400	0	547	2	210
3	Do by Fork run to middle fork of Howard's creek,	do	0	400	0	1,000	3	800
4	Do by Middle fork of Ogley's creek to Anthony's creek,	do	0	727	2	943	4	883
5	Do by Ogley's to the north fork of Howard's creek,	do	0	383	0	1,285	5	1,523
6	Do by Ogley's creek to the middle fork of Howard's creek,	do	0	383	0	1,000	6	783
1	- - - - - - - - - -	700	1	283	0	1,217	11	
2	- - - - - - - - - -	do	0	430	0	1,017	3	333
3	- - - - - - - - - -	do	0	430	0	901	4	317
4	- - - - - - - - - -	do	0	717	3	500	5	1,716
5	- - - - - - - - - -	do	0	300	0	860	6	1,187
6	- - - - - - - - - -	do	0	300	0	901	6	1,500
1	- - - - - - - - - -	650	0	440	0	1,550	11	933
2	- - - - - - - - - -	do	0	350	1	73	4	
3	- - - - - - - - - -	do	0	350	0	1,013	5	150
4	- - - - - - - - - -	do	0	684	1	793	9	773
5	- - - - - - - - - -	do	0	30	0	1,320	7	760
6	- - - - - - - - - -	do	0	30	0	1,013	7	547
1	- - - - - - - - - -	600	0	293	0	1,650	11	1,277
2	- - - - - - - - - -	do	0	407	1	964	5	600
3	- - - - - - - - - -	do	0	407	1	190	5	1,217
4	- - - - - - - - - -	do	0	660	1	427	10	1,067
5	- - - - - - - - - -	do	0	283	1	156	8	730
6	- - - - - - - - - -	do	0	283	1	190	8	383

By a reference to the foregoing table, it is at once perceived that, within the assumed elevations of a summit level, a shorter tunnel would be requisite to pass the Alleghany Mountain by the 2d or 3d routes, than by either of the others; and it will also be seen that the length of tunnel increases very rapidly on either of those routes as we descend below 700 feet; while, at any greater elevation, the diminished length of tunnel does not constitute a sufficient advantage to compensate for the increased lockage, the greater length of feeder, or to induce us to forego the advantages of a reservoir on the Greenbrier in its passage through the Droop Mountain; when the fall of the river is known to be greatest, and its valley so contracted that the least area, in proportion to the contents of the reservoir, would be exposed to the influence of evaporation.

We therefore assumed a summit level at the elevation of 700 feet above the base mark, and from its western end on the 2d route, a line of feeder was traced, at an inclination of 6 inches per mile, to its intersection with the Greenbrier river. This line from the relative positions of the routes of course passed them all, (except No. 1, which was abandoned because of its excessive length of tunnel,*) and enables us to determine very nearly the length of feeder for any route.

Deferring at this time the more detailed account of the difficulties opposed to a feeder, in its progress from the Greenbrier river to the summit level of the second route—which as yet is conspicuous for its advantages over the other routes—it may suffice our present purpose to state; that the *spur* which was spoken of (page 12,) as projecting from the Alleghany to the mouth of Howard's creek, or which lies between Howard's creek and the Greenbrier river, constitutes a great objection to every route, but the 4th.

So circuitous a route for the feeder, as that around the extremity of the spur, might, and probably would, involve such losses in its course as to be fatal to the practicability of the project; while the alternative of passing the spur in the direction indicated by the near approach of two opposite tributaries to the north fork of Howard's creek on the one side, and to Anthony's creek on the other, however it may diminish the chance of an inadequate supply of water, or may assure us of a probable superabundance, is fraught with difficulty.

The greatest depression, in the ridge intermediate to Howard's and Anthony's creeks, is at the sources of the two tributaries just alluded to, through which it had been hoped the feeder might reach the valley of Anthony's creek by an open cut, or a tunnel of moderate length. But it was found to be 1096 feet above the base mark, and

* To recur to the reasons why but one experiment was made from Dunlap's to Second creek—the great length of tunnel by the first route could not be diminished by any route to Second creek. For the mouth of Cove creek, (the next tributary to Dunlap's creek above Fork run,) is six hundred feet above the base mark, and the rise in Cove creek being greater than in Dunlap's creek, we should, by a route through Cove creek, have to commence tunnelling at even a greater distance from Second creek than by the first route. Indeed a route from Dunlap's to Second creek would be impracticable at any rate, in consequence of its distance from Greenbrier river, and of the character of the intermediate country.

the slope on either side so gradually, that, limiting the cuts to 35 feet depth, a tunnel of 5 miles and 1,620 yards will be required.

Were the summit level 50 feet, or even 100 feet higher than has been assumed, still the length of tunnel to pass this ridge would be, in the one case four miles and 290 yards, and, in the other, 3 miles and 533 yards. But the considerations which heretofore induced us to limit the elevation of the summit level to 700 feet, cannot safely be waived; and therefore, in selecting the location for a feeder, the disadvantages of a tunnel of four miles and 1,620 yards by one route, are to be weighed with the uncertainties attending the very greatly increased length by the other.

In comparing the different routes for a canal, however, and the practicability of each, we shall confine our view to the shorter route for the feeder, and on that supposition the following table comprises their principal characteristics:

TABLE.

No. of route.	Cut east of the Alleghany.		Cut west of the Alleghany.		Length of tunnel.		Length of the summit level.		Distance from base mark to summit level.		Dis. thence to mouth of Howard's creek.		Total dis. from base mark to mouth of Howard's creek.		Height of Alleghany.	Feeder to the summit level.	
	m.	yds.	m.	yds.	m.	yds.	m.	yds.	m.	yds.	m.	yds.	m.	yds.	Feet.	m.	yds.
2	0	430	0	1,017	3	333	4	20	20	913	8	1,713	33	866	1,092	38	623
3	0	430	0	901	4	317	4	648	20	913	8	880	33	1,631	1,221	35	1,183
4	0	717	3	500	5	1,716	9	173	16	220	19	1,000	45	633	1,772	26	403
5	0	300	0	860	6	1,187	7	587	11	1,540	9	130	28	597	1,534	33	1,723
6	0	300	0	901	6	1,500	7	941	11	1,540	8	880	27	1,601	1,288	35	1,183

NOTE.—The last column develops the length of the feeder as actually traced, but it became apparent, on plotting the work, that judicious deviations from the first trace would reduce the longest feeder to about 33$\frac{3}{4}$ miles, and the others in proportion.

The shorter tunnel required by the 2d route, to pass the Alleghany Mountain, is decisive of its preference over any route but the 4th, which, being nearer the Greenbrier river, and alone exempt from the difficulties which attend a feeder to any summit level beyond Anthony's creek, we shall compare more closely with the 2d route.

The 4th route is 11½ miles, the longer of the two; and the length of its tunnel through the Alleghany exceeds that of the 2d route by 2 miles 1,483 yards; while, by the 4th route, we avoid 12 miles of feeder, which includes a tunnel of 4 miles and 1,620 yards.

Now the cost of constructing 12 miles of feeder, even with a tunnel of 4 miles and 1,620 yards, certainly, I think, would be less than the cost of 2 miles 1,483 yards of a tunnel of such dimensions as would be adapted to the navigation of canal boats; and, to say nothing of the cost of 11½ miles of canal, on the score of comparative expense, the 2d route would seem preferable to the 4th. If, therefore, it shall appear, that, notwithstanding its greater length of feeder, an adequate supply may be depended on, since the accomplishment of the same objects would result from the adoption of either route, the difference of expense in favor of the 2d route will be considered conclusive of its preference.

Without entering into a recapitulation of all the calculations to be found in Lieutenant Dillahunty's report, relative to the supply of water, we shall, as concisely as may be, state the results which have, in our view, established the practicability of the project under consideration.

From a careful and repeated guaging, at intervals, during two successive years, of the streams on which we rely, we find that their minimum supply was as follows, viz:

Greenbrier river,	43.3	cubic feet	per	second
Anthony's creek,	11.6	"	"	"
Dunlap's creek,	9.3	"	"	"
Howard's creek	6.83	"	"	"

Besides which, a reservoir may be formed on the Greenbrier river, above the commencement of the feeder, to the summit level, by a dam 50 feet high, which shall contain 13,060,584.9 cubic yards.

To compute the sufficiency of this supply, let the same suppositions apply to this route, as were adopted by the United States' Board of Internal Improvements, with regard to the proposed Ohio and Chesapeake Canal.

They have assumed an interruption of the navigation during the Winter season, which, from the elevation of the summit level, 1,905 feet above the ocean, they suppose to include the four months of December, January, February, and March. The summit level of the proposed James and Kenhawa canal, it is true, is farther south, but it is equally elevated (1,940 feet above the ocean;) and I have not perceived any essential difference in the climate.

During such a suspension of the navigation, if we only adopt 67.6 cubic feet per second as the mean discharge of the Greenbrier, (whereas we believe that to be much less than the mean discharge during the

Summer months) it will be found that the reservoir would be filled twice, or once, in about two months: and if we add to this view, a computation of the supply we may reasonably expect from rains, the replenishing of the reservoir will not only seem certain, but the superabundance from that source alone, will appear more than ample to repair all losses attributable to the reservoir and feeder, from the influence of evaporation, absorption, &c.

From an inspection of the map of Virginia, and our own knowledge of the extent of country drained by that part of Greenbrier river above the reservoir, we know that the sum of the lengths of the streams exceeds by far 110 miles; and that an average of the widths of their valleys is more than half a mile. But, if we assume that an area of but 55 square miles is drained by the upper part of Greenbrier and its tributaries, and calculate on no greater annual fall of rain in the elevated region in which it is situated, than was observed to be the least quantity which fell in the vicinity of Baltimore in in any one year, during a period of eight years, we find that an area of but 55 square miles would receive during

The Fall and Winter,	78,880,384	cubic yards,
The Spring and Summer,	59,117,696	" "
The whole year,	137,998,080	" "

From which, to continue the reasoning of the Board, it is seen, 1st, that two-thirds of the first quantity, or 52,586,929 cubic yards, is more than four times as much as will be necessary to fill the reservoir in four months; and 2d, that 59.117,696 cubic yards, or the second quantity, is equivalent to upwards of one hundred cubic feet (102.63) per second, during six months; and might be deemed the mean discharge, during the Spring and Summer months, instead of 67.6 cubic feet, which we have assumed for the mean supply of the Winter months.

That the truth of this last deduction may be less doubtful, it is to be remarked, that, if we have apparently lost sight of the filtrations and evaporations of rain water, 55 square miles is by no means equal to the whole extent of country drained above the reservoir; that the usual quantity of rain is much greater than has been assumed; and that our own observations would lead us to believe the mean supply of Greenbrier river, during the Summer months, to be more than 100 cubic feet per second.

However, to forego further speculation, and to return to the supply of water on which, by the most unfavorable supposition, we may rely—omitting at this time, the supply from Dunlap's creek and Howard's creek, which is taken in below the summit level—we have a reservoir with an area of 2,508,333 square yards, whose prism of available water is 13,060,584 cubic yards; 43.3 cubic feet per second, from Greenbrier river, and 11.6 cubic feet per second, from Anthony's creek; or, a total supply from Greenbrier and Anthony's creek, of 54.9 cubic feet per second—say 55 cubic feet.

This quantity is to meet the losses of a feeder 55¾ miles long, to supply the lockage of the canal, and the losses by filtration and eva-

poration of the summit level and the portions of canal on either side of it, which, together, include about 11¾ miles—besides making up such deficiency as may arise from the inadequacy of Dunlap's creek, to supply about 17¾ miles of canal; and of Howard's creek, to meet the losses of but four miles of canal.

We impute no loss to the reservoir from filtration and evaporation, both because we are assured that the mean discharge from Greenbrier river, beyond what we have assumed to be the *minimum*, renders such an allowance unnecessary; and because the shape of the valley will admit the raising of the dam to any height, to add to the reservoir a sufficient quantity to overbalance it.

We may calculate, then, on a monthly supply of

1,632,573.1 cub. yds. from the reservoir,

5,168,888.08 " from Greenbrier river and Anthony's creek,

or 6,801,461.18 " for the total monthly supply.

From this quantity, however, we must deduct, to obtain that available at the summit level, the losses of the feeder in its course from Greenbrier river. With an area for its transverse section of 10 square yards, and a length of 33⅔* miles, the feeder will contain 592,535 cubic yards, and we will make the extravagant supposition that it may lose the whole of its prism every 15 days, or 1,185,070 cubic yards per month. Deducting this quantity from the total monthly supply, there will remain 5,616,391.18 cubic yards, which is thus compared with the remaining requisitions dependent on it.

Waiving a particular recital of the *arrangement* of the trade, we will suppose it limited to 100 boats per day; that the boats pass the locks alternately; and that, consequently, no boat would of necessity expend more than one lock full of water in its passage of the summit level. But, as a prudent provision for contingencies, let it be assumed that each boat will require a lockful and a half, or, the locks being of the same dimensions as were proposed for the Ohio and Chesapeake Canal, 623 cubic yards.

The monthly allowance for lockage then, if 3,000 boats should pass the summit level, will be 1,869,000 cubic yards; which, taken from 5,616,391.18 cubic yards, (the available supply, after deducting the losses of the feeder,) leaves 3,747,391.18 cubic yards. If this residue were all that we could command to supply the canal in its whole course from the mouth of Dunlap's creek to the mouth of Howard's creek, a distance of about 33½ miles—whereas, not quite half that distance is dependent on it—it would abundantly meet all the losses of the canal from absorption, filtration, and evaporation.

But let us add to this residue but 5 cubic feet per second, for the supply from Dunlap's creek—but little more than half the minimum supply, we have ever known it to yield—and 6 cubic feet per second from Howard's creek, and we shall realize an accession to our monthly supply of 1,056,000 cubic yards; or we shall have 143,384.8 cubic yards per month per mile, to secure the canal from its losses by evapo-

* See *Table*, page 16.

ration, absorption, and filtration ; an allowance equivalent to nearly ninety cubic feet (89.6) per mile per minute.*

The relative situations of the *Cheat* and Greenbrier rivers, with the opportunity of forming a succession of reservoirs in the valley of the latter, suggest additional security against any probable failure in the supply of water ; but it is needless to amplify a discussion already so far extended, that the most cautious may not cavil at the conclusion that a *canal from the James to the Kenhawa river*, by the valleys of Dunlap's and Howard's creeks, *is demonstrably practicable.*

To the determination of this question, I have before remarked, all the preliminary operations of the first season were exclusively directed ; and, so far, we have been confined entirely to the results afforded by the *experimental* surveys. But, pursuant to my instructions, that, "for the practicable works, the surveys must be performed in such a manner as to afford the route itself of the work, with all the circumstances of the ground which have a bearing upon excavation embankment, crossings by aqueducts and culverts, dams, &c ;" when in May, 1827, the surveys were resumed, the precise location of a line of canal, from the respective heads of boat navigation on the James and Kenhawa rivers, was the next object which occupied my brigade.

The location of that portion of canal between Covington and the mouth of Howard's creek, with that of all the works connected with the summit level, such as feeders, reservoirs, &c., was constituted one object, and its accomplishment assigned to Lieutenants Cook and Fessenden. The continuation of the canal through the valleys of Greenbrier and Great Kenhawa rivers, from the mouth of Howard's creek to the foot of the Great Falls, with all the considerations incident to the project, another object; the accomplishment of which, was entrusted to Lieutenants Hazzard and Thompson.

The reports of Lieutenants Cook and Hazzard, which are hereto appended, with the different maps and profiles relating to the route, will fully exhibit the details, which I may omit to mention—such as the length of each level, the lift of each lock, the transverse, as well as longitudinal slope of the ground, including the works, the nature of the soil, rocks, &c. the height of freshets. It will remain to me, however, to present a connected, and more general view of the whole route.

To facilitate a perspicuous arrangement of the subject, let the *first section* extend from the James to the Greenbrier river ; the *second section* include that portion of canal along the Greenbrier ; and the *third section*, that portion between the mouth of Greenbrier and its termination at the foot of the Great Falls of Kenhawa.

* The United States' Board of Internal Improvements, in their report of October 23d, 1826, on the Ohio and Chesapeake Canal, (page 54,) admits the sufficiency of 120,000 cubic yards per mile per month, as an allowance for absorption, evaporation, and filtration. And Dr. William Howard, United States' Civil Engineer, in his "report on the survey of a canal from the Potomac to Baltimore," remarks that "1½ cubic feet per second per mile, appears a far more ample allowance than will be needed for the *lockage*, evaporation, and filtration, of a canal placed in favorable circumstances for retaining water."

1st. Section.—The minuter surveys incident to the locations included in this section, while they test the accuracy of the experimental surveys, develop results somewhat different. The elevation of the summit level, for instance, was established at 694 feet, instead of 700 feet, as heretofore assumed, and the depth of cutting, at either end of the tunnel, through the Alleghany, was extended to 50 feet, instead of 35 feet, to which, in comparing the lengths of tunnels by the different routes, we had limited it. The reason for changing the elevation of the summit level, are not perhaps important, but the depth of cutting was extended to 50 feet, because it was found that the tunnel would be materially shortened; illustrative of which fact, I would add, that, on the western side alone, the length of the tunnel is diminished 533 yards, by extending the cut to the depth of 50 feet.

Dividing this section into three parts, the *first subdivision* will comprise the summit level, and all the works belonging to it. The length of the summit level is 4 miles 789 yards, which distance includes a short basin of 98 yards in the valley of Fork Run; a deep cut at the eastern end of the tunnel of 458 yards; a tunnel through the Alleghany, of 2 miles and 1,120 yards; a cut at the western end of the tunnel of 1 mile 177 yards; and a basin from the termination of the latter cut, which extends 696 yards.

The profile of the ridge immediately over the tunnel, indicates frequent great depressions, where it crosses the ravines of the head branches of Fork run and Tuckahoe, although, between those depressions, the ridge sometimes attains a very great height above the summit level. But the necessity, and to what extent, of sinking shafts, in the construction of the tunnel, where those depressions do not exist, will be better seen by designating their position in the following tabular form:

No. of depression.	Distance from the end of the deep cut at the eastern end of the tunnel.		Height of depression, above the summit level.	Greatest height of intermediate ground.	Distance from each depression to the one preceding.
	MILES.	YARDS.	FEET.	FEET.	YARDS.
1	0	500	160	245	500
2	0	740	166	203	240
3	0	953	126	249	213
4	0	1,183	180	230	230
5	0	1,516	300	574	333
6	1	353	276	578	597
7	1	773	458	550	420
8	1	1,017	515	605	244
9	1	1,677	205	706	660
10	2	500	130	368	583
11	2	1,120	50	384	620
					end of tunnel.

In relation to the probable formation of the ridge through which the tunnel would pass, of course we cannot speak with any certainty; but appearances at and near the surface in the vicinity, would incline us to expect the interposition of compact sandstone the greater part of the distance.

The cutting, at either end of the tunnel, it is thought, will prove as favorable for its depth as could reasonably be expected any where; it will probably consist principally of an argillaceous slate, and sandstone of slaty structure, intermixed with a soil (nearer the surface) of sand and clay.

Feeder from the Greenbrier river to the summit level.—The location of this work does not vary materially from that pursued by the experimental surveys. Its length has been diminished to 31 miles 130 yards, but it still involves a tunnel of 5 miles and 200 yards. The same formation will, doubtless, be encountered by this tunnel as by that through the Alleghany Mountain; and the cutting, at either end of the tunnel, will be similar to what is expected in the deep cuts of the summit level.

The height of the ridge above the surface of the water in the feeder, at different points from the beginning to the end of the tunnel, is shown in the following table:

No. of depression.	Distance from the end of the deep cut at the beginning of the tunnel.		Height of depression above the surface of the water in the tunnel.	Greatest height of intermediate ground.	Distance from each depression to the one preceding.
	MILES.	YARDS.	FEET.	FEET.	YARDS.
1	•	1,260	100	262	1,260
2	1	690	153	199	1,190
3	1	1,006	204	253	316
4	1	1,374	211	351	368
5	2	409	298	547	795
6	2	799	373	424	390
7	2	1,066	419	550	267
8	2	1,426	356	604	360
9	2	1,622	482	529	196
10	3	52	513	599	190
11	3	362	772	804	310
12	3	675	718	799	313
13	3	888	733	747	213
14	4	15	703	929	887
15	4	155	712	777	140
16	4	435	852	898	280
17	4	735	897	954	300
18	4	1,235	585	descending.	500
19	5	200	35		725

The tunnel begins and ends where the cutting is but 35 feet deep.

It will have been observed that the height of the ridge above the tunnel far exceeds the height of the depression spoken of (page 14.) and the observation leads to the inquiry, if it might not be better to give the tunnel the direction of those valleys which head in that depression, instead of a perfectly straight direction through the ridge.

In that event the greatest height of the ridge above the tunnel need not exceed 300 feet, and the profile will show that, on both sides, the ground rapidly falls to within 150 feet above the tunnel.

We could conform to the direction of the opposite valleys, and continue the tunnel straight, or very nearly so, till it reached the valley of Anthony's creek, when one turn would be necessary. Its length, under those circumstances, would be 5 miles and 950 yards, or it would be but 750 yards longer than if it were perfectly straight. I am, however, rather inclined to think it fortunate that such appalling difficulties as would obstruct the progress of a straight tunnel, can so easily be diminished, than to hesitate in recommending the longer tunnel, because of its increased length ; and I would, therefore, add, for the whole length of the feeder, the difference between the lengths of the two tunnels, to 31 miles 200 yards.

Lieut. Cook's report will furnish every other fact connected with the feeder from Greenbrier river, or relative to the reservoir on that river. The feeder *from Anthony's creek*, he has omitted to mention, intersects the main feeder in the 11th mile from the summit level ; it is one mile and 1,509 yards long, and passes down the right shore of Anthony's creek, without any difficulty : the dimensions of the dam at the head of this feeder are shown on the map.

2d *Subdivision.*—This extends from the eastern end of the summit level to the James river, opposite the town of Covington, and includes 19 miles and 73 yards of canal, and 692 feet of lockage, to the surface of a basin suitable to the reception of the canal boats.

For the first two miles and 1,072 yards from the summit level, or that included in the valley of Fork run, we unavoidably fall 264 feet ; preserving, however, with some exceptions, in which resort is had to *contiguous* locks, a succession of short levels, connected by locks of eight feet lift.

The descent from the first to the second level, and from the seventh to the eighth level, was effected by two contiguous locks ; while the third and fourth levels are united by five, and the tenth and eleventh levels by four contiguous locks.

The actual descent of the valley in positions where it was essential to conform as much as possible to that descent, to avoid rocky and precipitous slopes which would else have been encountered ; or, in other cases, expensive and deep embankments over broad and deep ravines ; in fine, a regard to the various circumstances of the ground, sometimes recommended a combination of locks, in preference to a succession of levels.

Even with such a disposition as was made of the locks, the canal, down the valley of Fork run, passes along a very steep slope, vary-

ing from 12° to 38°, till within about ⅘ths of a mile of Dunlap's creek, when it occupies a flat.

For the remainder of this subdivision, (16 m. 761 yds.) or that in the valley of Dunlap's creek, the canal was located under much more favorable circumstances; the fall being much less in a given distance, and the valley much wider. As I have remarked in another part of this report, bottom lands always present themselves on one or the other side: and although these alternate with bluffs and occasional cliffs, which have more than once induced us to cross the stream, neither the lengths nor heights of the aqueducts would be such as to render them very expensive. It may be satisfactory, however, to observe, that, whatever difficulty may have presented itself on one side, the creek has never been crossed, till, from an actual experiment on both sides, it seemed proper to do so; and the field notes may therefore be referred to, for the precise motives which determined the location adopted for the canal.

From the mouth of Fork run to its termination opposite Covington, the Canal is divided into 50 levels, connected with each other, as heretofore, by locks of eight feet lift, except in three instances, where the descent is made by two contiguous locks. The descent from the last level to the basin proposed at the end of the canal is effected by a lock of 12 feet lift.

The excavation along Dunlap's creek will, in general, be of the easiest kind, through bottoms, or along hill sides of sand and clay, sometimes mixed with argillaceous slate. The bottoms are uniformly composed of a vegetable mould about a foot thick, resting on a bed of clay. Limestone is found in the valley of Dunlap's creek, opposite the canal, near Crow's tavern, and in several other places, but it was not observed to intersect our line; in fact, we have little apprehension that the canal would experience more than the ordinary losses incident to similar works favorably situated for retaining water.

Provision was made for the introduction into the canal of the supply afforded by Dunlap's creek; it is to be very easily effected by a short feeder of but 610 yards length, from a dam barely high enough to divert the course of the stream. The situation of the dam is not far below the mouth of Fork run, and the level into which the supply is introduced is two miles and 1718 yards from the summit level.

3*d Subdivision.*—This comprises a succession of short levels connected by single locks, of the uniform lift of eight feet, and extends from the western end of the summit level, through the valley of Howard's creek, to the left bank of Greenbrier river; it includes a distance of eight miles and 155 yards, and a descent of 216 feet.

It is unnecessary, however, to dwell upon this subdivision: it presents no difficulty deserving of particular comment, and all its features are sufficiently developed on the map. The supply from Howard's creek, if at all needed, may, perhaps, with most facility, be brought into the 16th level, which begins just below a very rapid part of the creek. A feeder of but 333 yards length, with a dam 20 yards long and 7 feet high, would be sufficient.

A review of the 1*st Section* of the canal affords the following summary of some of its principal features:

	Distance.		Number of Locks.	Ascent.	Descent.
	Miles.	Yards.		Feet.	Feet.
James River to summit level, - -	19	73	86	692	
Summit level, - - - - - -	4	789			
Summit level to Greenbrier River, -	8	155	27	- -	216
Total, - -	31	1017	113	692	216

FEEDERS.	Length.	
	Miles.	Yards.
From Greenbrier River to summit level, - - - - - -	31	130
From Anthony's creek to main feeder, - - - - - -	1	1509
From Dunlap's creek to 27th level of canal, - - - - -	-	610
From Howard's creek to 16th do. do. - - - - -	-	333
Total length of feeders, - - - -	33	882

I have omitted to advert to the diminished contents of the reservoir on Greenbrier river, resulting from Lieut. Cook's selection of the site for a dam, (see his report, page 41,) because no doubts as to the adequacy of the supply have arisen from that circumstance. For it will be perceived that, by increasing the height of the dam to 60 feet, we can reserve 14,000,000 cubic yards, instead of 13,060,584; on which latter quantity our former reasoning was predicated, and which, it has been shown, would leave a superabundance beyond all the wants of the canal.

2d Section.—The first section terminating but 33 feet above low water mark, viz. the surface of canal, it is thought advisable to prolong that level across the river: for the height to which freshets sometimes rise might else endanger the security of the aqueduct.

The length of the aqueduct under those circumstances, would be 167 yards, at the end of which we descend by two locks, of eight and a half feet lift each, to what Lieutenant Hazzard terms his *first* level. An additional supply of water may, with great ease, be introduced into the canal on either side of the river, even at the elevation of the aqueduct. A feeder on the left shore of but 1260 yards in length, from a dam 13 feet high and 108 yards long, would effect the object. But I think it to be preferred that the new supply be admitted just beyond the aqueduct, from which to a dam, of even less elevation, a shorter feeder along the right shore would answer equally well.

Arrived at the first level beyond the aqueduct, the location of this section was continued, under various circumstances, to its termination at the mouth of Greenbrier river. The cliffs which impinge upon the

stream, and which at times the canal unavoidably encounters, may rather be considered exceptions to the otherwise generally favorable nature of the ground, than as characterizing this section as at all remarkable for the extent of the obstacles to its easy execution.

Its length is 49 miles and 151 yards, which distance is subdivided into 36 levels, (the aqueduct being included,) united by locks of the uniform lift of 8 feet, excepting the two locks of eight and a half feet lift, at the end of the aqueduct across the Greenbrier; the canal, therefore, descends 297 feet in its progress to New river.*

The only tributary streams of any consequence crossed by this section of canal, are Mill creek, Muddy creek, and Hunger's creek; the first requiring an aqueduct 100 feet long and 17½ feet high, and the two others, aqueducts of but 50 feet length and 17½ feet height. It does not appear advisable to introduce either of them into the canal: for every facility exists for obtaining an abundant supply from the river, to which we must necessarily resort. Suitable sites for dams, across Greenbrier very frequently occur, but their positions and dimensions will readily be seen on reference to the maps.

On the left, or east side, as we descend below Howard's creek, the number and magnitude of the tributary streams are also so limited, that we are led to ascribe the increased size of Greenbrier river, observable in its progress to New river, rather to the existence of numerous springs which rise within, or near its bed, than to contributions from more distant sources—Second creek, perhaps, being the only stream from the left, which materially adds to the volume of the river.

3*d Section.*—This extends 67 miles and 779 yards, and includes a total descent of 762 feet, to the surface of a natural basin below the *Great Falls* of Kenhawa river; and it is the peculiar character of a portion of the valley included in this section, which would present the most appalling difficulties to the construction of a canal.

For 45 miles, or to *Bowyer's ferry*, obstacles such as are almost continuous between Bowyer's ferry and the Gauley river, are confined to but a comparatively small portion of the distance; but below Bowyer's ferry it would be only at great expense that the canal could be protected against the impetuosity of a current, almost resistless during the swollen stages of the river.

This is exemplified in the fact, that freshets sometimes attain the great height of 35, and even 50 feet in some places. Within whose utmost reach, there could be no security to the durability of any work; and, from the nature of the intermediate space between low water mark and the cliffs, which rise nearly perpendicularly for several hundred feet. For, notwithstanding, even below Bowyer's ferry, there is, generally, room enough for the canal between low water mark and the cliffs, and that the interval may never be wholly overflowed, it is occupied by masses of huge rocks, exhibiting a surface almost too irregular to be defined. These rocks, however, may be

* The Great Kenhawa river is more familiarly known as *New river*, above its confluence with the Gauley river.

converted into a kind of *bench*, on which the canal could be sustained beyond the reach of freshets, and eventually might facilitate its construction; but the necessity of high and extensive walling would still exist, and the total absence of any suitable material for *puddling* the canal would be irremediable, except at the cost and trouble of procuring it from a distance, unless indeed clay of a proper consistency be obtained near the verge of the cliffs, when this latter source of expense may be very much diminished, from the ease with which it might be deposited at convenient intervals along the line.

The rocks at the foot of the cliffs have every appearance of having, at some period, been precipitated from different points of the cliffs, and, although ages may have since elapsed, it must be obvious that it would be impossible to secure any work at the base of the cliffs against the destructive effects of a similar recurrence. It is not conceived, however, that much importance is due to this suggestion, since there is little probability that such masses as those alluded to, would, in future, be detached, unless by some extraordinary convulsion of nature beyond what we have reason to anticipate.

Above Bowyer's ferry, the valley is much wider, and, although the canal would frequently occupy steep slopes, such difficulties as exist below are not to be apprehended, either from the heights of freshets, or the perpendicularity of the banks. No trace was perceived of the water ever having risen more than 13 feet above its ordinary channel until within a few miles of Bowyer's Ferry; and, with the exception of few places designated by Lieut. Hazzard, as requiring walling to protect the canal, there is comparatively but little difficulty in sustaining the line beyond the reach of freshets.

The tributaries to New river, between Greenbrier and the Gauley rivers, are few and unimportant; and the Great Falls of Kenhawa, 2 miles below the Gauley, designates as well the commencement of an entirely different country from that above, as the termination of our ideal *section*.

Tug Falls, *Buffalo Falls*, *Richmond's Falls*, and the *Great Falls*, with an almost continuous *rapid*, when perpendicular falls do not occur—in all, constituting a spectacle, the sublimity of which can scarcely be surpassed—characterize New river below its confluence with the Greenbrier, as an impetuous and almost resistless torrent: And the general aspect of both sides of the river, with the wild features of its valley, can offer few temptations to the intrusion of civilized man. But the Great Kenhawa majestically pursues its placid course through a rich and fertile valley, and is said to present but few obstructions to a perfect navigation from the Falls to the Ohio River.

The general structure of the country below Greenbrier river is based on sandstone, (grey and red,) or, a compact limestone; and *coal* of an excellent quality exists, in exhaustless quantities, from Sewell mountain westward.

Having now sufficiently reviewed the several sections in detail, the following summary of the whole route, will conclude the subject which has heretofore occupied us.

SUMMARY.

	Distance.		Lockage.
	Miles.	Yards.	In feet.
James river to the Greenbrier river, -	31	1017	908
Thence to New river, - -	49	151	297
Thence, to the basin below the Great Falls	67	779	762
Total -	148	187	1,967

ROANOKE AND KENHAWA CANAL.

On completing the surveys relating to a canal from James River to the Great Kenhawa, those having reference to other objects enumerated in my instructions, were immediately undertaken; and, although a detailed report on the *Roanoke and Kenhawa Canal*, is unavoidably postponed till the drawings illustrative of the survey shall be more advanced, a brief summary of the more important facts may, at this time, be satisfactory, as it will suffice to shew the great facility with which those rivers may be united.

The experimental surveys, which extended along the Alleghany Mountain, from the southern source of one of the branches of the *north* fork of Roanoke, beyond Christiansburg on the north, to the south fork of Elliot's creek, on the south, indicate the existence of frequent great depressions in the dividing ridge, or rather a general depression of the Alleghany Mountain in its course between the waters of the Roanoke, and those which, flowing westward, empty into Little river.

But the point which imposingly presents itself as offering superior advantages for the passage of the Alleghany by a canal, is at the sources of the *north fork of Elliot's* creek, a tributary to the *south* fork of Roanoke, and "Green Head Branch" of Meadow creek, a tributary to Little river.

An abundant supply of water might be obtained from Little river, even were our summit level of the same elevation as that of the very top of the mountain, in the depression alluded to; but, apprized of that fact from the results of our experimental surveys, sufficient considerations recommended, notwithsatnding, a location of the canal in the following manner:

The *summit level* commences, on the east side, with a cut which, in one thousand three hundred and twenty yards, attains its greatest depth of thirty feet, (above the *surface* of the canal,) and, terminating on the west side one hundred and forty-four yards beyond the end of the cut, includes, in all, one thousand four hundred and sixty-four yards.

The canal then descends, through the valley of Meadow creek, to Little river, and thence, along Little river, to New river, under circumstances as favorable as might be expected—no difficulties occur-

ring worthy of comment at this time—the distance from the summit level to the latter point being ten miles seven hundred and sixty-nine yards, and the fall two hundred and eighty-eight feet.* From the mouth of Little river it is prolonged on the right bank of New river to its intersection with the James and Kenhawa canal; and to the mouth of Greenbrier, for most of the distance, the canal occupies very favorable ground, through extensive flats which border on the river.

These flats, however, are not continuous, and frequently, for short distances, we must encounter cliffs which impinge upon the streams; but, with the remark that the difference is rather in favor of the valley of New river, we shall not create an erroneous impression, if we refer to the location down the Greenbrier, as the standard by which we may judge of that between Greenbrier and the mouth of Little river.

Returning to the summit level, the descent on the eastern side, until we arrive within half a mile of the main valley of the north fork of Elliot's creek, is such as to necessitate a succession of short levels, and the canal falls, by locks of eight feet lift, one hundred and twenty feet in but one mile four hundred and eighty-five yards; the next eleven miles one hundred and fifteen yards bring us to the mouth of Elliot's creek, and comprise sixty-two levels, and a descent of four hundred and ninety-six feet; whence, through the wide and fertile valley of the south fork of the Roanoke, the location extended to the *forks*, where the field operations of the Brigade terminated for the season.

The distance from the mouth of Elliot's creek, to the termination of the canal near the forks of the Roanoke, is nine miles one thousand three hundred and twenty yards, and the fall two hundred feet.† The canal, therefore, from the mouth of the Greenbrier river to the latter point includes an *ascent* of 657.7 feet, in a distance of ninety-four miles and one hundred and six yards, (the distance from the Greenbrier to the mouth of Little river, being eighty-three miles and one thousand and ninety-seven yards, and the rise 369.7 feet); a summit level of one thousand four hundred and sixty-four yards, and a descent, in twenty-two miles, one hundred yards; of eight hundred and sixteen feet; or the total distance is one hundred and sixteen miles and one thousand seven hundred and thirty yards, and the lockage 1,473.7 feet.

Supply of Water.—It is the great facility with which this is obtained that so distinctly characterizes the connexion in view, as one so very feasible in its execution. Little river, on which the summit level is dependent, was found to yield, at its lowest stage, nearly one hundred cubic feet per second, when its supply can be commanded by a feeder but nine miles and one thousand two hundred and twenty-five yards long.

Pilot Mountain, however, which lies between Little river and the summit level, preserves such an elevated character, that the feeder

* The bench at the mouth of Little river, on the right bank, is 290 feet below the summit level, and 16 feet above low water mark.

† The bench mark *near the Mill*, at the forks of the Roanoke, is eight hundred and thirty-one feet below the summit level.

can only pass it by a tunnel of one mile and two hundred and ninety yards length. We might indeed wind along the slope of the mountain, but it would so very greatly increase the length of the feeder, that there can be no hesitation in preferring a tunnel. In other respects, the construction of the feeder would be attended with little difficulty.

The supply from Little river alone would be ample to all the wants of the canal from New river to the forks of the Roanoke; but a reference to the report of Lieut. Fessenden, which exhibits the discharge of the two branches of the Roanoke, of Elliot's creek, of Meadow creek, and the increased size of Little river in its progress to its mouth, will shew the abundance of its other resources.

Of the practicability, therefore, and comparative ease with which the Roanoke may be united to the Kenhawa, by means of a canal, the brief statement of facts which we have given will have been sufficient to dispel all doubt, and, on that conviction, we might forego all further discussion of the subject, but that a few other remarks naturally suggest themselves, as neither uninteresting, nor entirely irrelative.

If the connection be regarded merely as an avenue for the trade of the Ohio valley, its importance in that light may, doubtless, at some future day, elicit the effort to overcome those obstacles between Bowyer's ferry and the Great Falls, which constitute almost the sole impediment to its comparatively easy execution. But should the magnitude of these obstacles be considered sufficient forever to discourage the enterprise of a nation, the importance of the connection, although diminished, is yet conspicuous. New river for perhaps 100 miles above the mouth of Little river, it is said, traverses a country rich in mineral and agricultural products, and its navigation may prove easily susceptible of great improvement; while the direction of *Reed creek*, a tributary to New river, above its confluence with Little river, is particularly spoken of as promising facilities for effectuating a connection with the middle fork of the Holstein.

Of this I cannot speak from personal observation, nor from information entirely authentic, yet the concurrent opinions of individuals acquainted with the country, would seem to warrant a belief in the practicability of a canal from New river to the Holstein; and the relative situation of the Tennessee and Alabama rivers, as delineated on every map, renders it, by no means, improbable that they, also, might be united. Thus it is possible, and, I might even say, within the scope of probability, that a canal from the Roanoke to the Kenhawa may, at some future day, be regarded but as the last link in a chain of inland communication, from the *Gulf of Mexico* to the *Chesapeake*.

From "a due investigation of the hydrography and topography of the country," it is certain that "no other routes," than those which have been described, possess similar advantages for uniting either the James or Roanoke river with the Kenhawa, by means of a canal.

The country between Knap's creek, a branch of the Greenbrier, and Back creek, a tributary to Jackson's river, and between Craig's creek and Sinking creek, opposite tributaries to Jackson's and New river,

was said to afford some facilities for a canal from the James to the Kenhawa river, and was, in consequence reconnoitred. But it is apparent that no route, in either of those directions, can present any claim to further examination, (see Lieut. Dillahunty's report, page 64,) and the conclusion is equally obvious, from our present knowledge of the country, that the James river cannot be united by a canal with the waters of the Great Kenhawa, by any route *below the valley of Dunlap's creek;* unless, indeed, as is highly probable, a canal from James river through the valley of Catawba creek, be found practicable to the *Roanoke.*

The examination, however, of the country intermediate to the Roanoke and James rivers, with reference to a canal or rail road, is one of those objects enumerated in my instructions, which, as yet, from the want of time, has been omitted.

Of the practicability of a *rail road* from the James or Roanoke river to the Great Falls of Kenhawa, there cannot remain a doubt: and the surveys which have been made of the intermediate country will, in general, furnish ample means for deciding on the most proper routes. A single glance at the topography precludes all hesitation in selecting, for a rail road from *James* river, some one of the routes surveyed for a canal, in preference to a more direct route over the high and numerous ridges which intervene between the Greenbrier and Gauley rivers.

To be more explicit, however, with such deviations only as would result from the different characters of the two works, the route which has been adopted for a canal, as far as the mouth of *Muddy* creek, would be pursued for a rail road. A doubt is suggested as to the best direction for continuing the road beyond that point, only because it is possible that a route through the valley of Muddy creek and across to *Meadow river*, a tributary to the Gauley, (from the circumstance of their being but one ridge between Muddy creek and Meadow river,) may be found to possess advantages which may bring it in competition with a route through the valleys of Greenbrier and Kenhawa rivers.

But, supposing it to pursue the same route as the canal, as is thought most probable, the length of a rail road from Covington to the Great Falls of Kenhawa, would be about 148 miles, with a rise and fall of 2,763 feet, on the supposition of passing the Alleghany without a tunnel.

The surveys from the Roanoke do not altogether determine the best route for a rail road to New river, beyond which it would, of course, continue down the valley; but the discovery that the Alleghany is nearly as low at one of the sources of the *north* fork of the Roanoke, near Christiansburg, as on the route proposed for the canal, with the fact of the direction of the north fork being such as to afford a shorter route than one up the valley of the south fork, makes it more than probable that a rail road from the Roanoke would cross the Alleghany in the vicinity of Christiansburg.

However, whatever may be the deviations from our location of the canals, by the substitution of rail roads in their stead, they cannot be

so material as to interfere with those general considerations which may determine from what has now been stated, the comparative merits of rail roads and canals, as the means of uniting the James or Roanoke river with the Great Kenhawa.

Having now briefly adverted to the operations of my brigade, subsequent to the completion of the surveys relating to a canal from the James to the Kenhawa river, in concluding this report, I may be permitted to advert to the causes which have delayed its completion beyond the period at which the Department may have had reason to expect it.

A report, simply on the James and Kenhawa Canal, could have been presented at the commencement of the present session of Congress, but for circumstances entirely unforeseen. I allude to the experimental surveys in relation to the Baltimore and Ohio Rail Road, which were undertaken, with the assistance of my brigade, as late as the latter part of November, and continued through a considerable portion of the inclemency of Winter, when, heretofore, it has, in all cases, occurred that the maps and profiles, illustrative of the operations of the Summer season, have immediately succeeded our return to Winter quarters. And, since the completion of those experimental surveys, I have, from an impression that it would be more satisfactory to present an equally detailed report on both the James and Kenhawa and Roanoke and Kenhawa Canals, alternately employed myself, till within a few days only, on the former subject, and on a report on the Baltimore and Ohio Rail Road—awaiting a more advanced state of the drawings to collate the facts essential to an equally detailed report on the Roanoke and Kenhawa Canal. Time has not sufficed, however, to execute fully my intentions.

Which is most respectfully submitted by, sir, your very obedient servant,

WM. G. M'NEILL,
Capt. U. S. Top. Eng.

TOPOGRAPHICAL OFFICE,
Georgetown, March 24, 1828.

DETAILS belonging to each Level of the Second Subdivision of the contemplated Canal from Covington, on Jackson's River, to the Greenbrier River.

No. of Level.	Length of Level.	No. of Locks.	Aqueducts.		Culverts.		Walling.		Slope of Ground transverse to Level.	Nature of Excavation.	
			Length.	Height.	Length.	Height.	Length.	Height.			
	Miles. Yards.		Feet.				Yards.	Feet.	Degrees.	Soil.	Rock.
1	0 140	1	•	•	•	•	•	•	16, 30	sand and clay	loose rocks
2	0 295	2	•	•	6	4	•	•	17	do	do
3	0 152	1	•	•	6	4	•	•	37	do	
4	0 342	5	•	•	8	4	•	•	38	do	
5	0 143	1	•	•	•	•	•	•	38	do	
6	0 124	1	•	•	•	•	•	•	38	do	
7	0 160	1	•	•	•	•	•	•	38	do	rock
8	0 185	2	•	•	6	4	•	•	35	do	loose rocks
9	0 140	1	•	•	6	4	•	•	35	do	do
10	0 140	1	•	•	6	4	•	•	35	do	do
11	0 293	4	•	•	•	•	•	•	38, 35	do	rock
12	0 155	1	•	•	6	4	•	•	29	do	loose rocks
13	0 243	1	•	•	•	•	•	•	29	do	do
14	0 153	1	•	•	•	•	•	•	29	do	
15	0 163	1	•	•	•	•	•	•	12	do	do
16	0 153	1	•	•	•	•	•	•	12	do	do
17	0 120	1	•	•	•	•	•	•	12	do	do
18	0 196	2	•	•	•	•	•	•	38	do	do
19	0 300	1	20	8	•	•	•	•	flat	do	
20	0 133	1	•	•	•	•	•	•	do	do	
21	0 194	1	•	•	•	•	•	•	do	do	
22	0 167	1	•	•	•	•	•	•	do	do	
23	0 465	2	20	15	•	•	•	•	flat, 20, 18	do	
24	0 325	1	•	•	•	•	•	•	18, 40	do	
25	0 160	1	•	•	•	•	•	•	40, 20	do	
26	0 153	1	•	•	6	4	•	•	21	do	
27	0 153	1	•	•	•	•	•	•	do	do	
28	0 153	1	•	•	•	•	•	•	flat	do	
29	0 834	1	•	•	•	•	•	•	do	do	
30	0 443	1	•	•	•	•	•	•	do	do	
31	1 0	1	60	10	6	4	•	•	do	do	
32	0 690	1	•	•	6 6	4 4	•	•	2, 6	do	
33	0 706	1	•	•	6 6	4 4	•	•	6, 17	do	
34	0 1251	1	•	•	6 6	4 4	•	•	36, 24, 5	do	
35	0 210	2	•	•	6	4	•	•	32	do	
36	0 176	1	•	•	•	•	•	•	flat	do	
37	0 204	2	•	•	6	4	•	•	do	do	
38	0 1350	1	•	•	6	4	•	•	do	do	
39	0 146	1	•	•	•	•	•	•	do	do	
40	0 710	1	•	•	6	4	•	•	19, 30, flat	do	
41	0 170	1	•	•	•	•	•	•	flat	do	
42	0 1000	1	•	•	•	•	•	•	flat, 26	do	
43	0 356	1	•	•	6	4	•	•	flat	do	
44	0 155	1	•	•	•	•	•	•	flat	do	
45	0 337	1	•	•	•	•	•	•	do	do	
46	0 690	1	•	•	6	4	170	11	flat, 44	do	rock
47	0 440	1	•	•	6	4	•	•	44, 5, flat	do	loose rock
48	0 700	1	•	•	6 6 6 6 6	4 4 4 4 4	80	13	flat, 44, 30, 2	do	do
49	0 164	1	•	•	6	4	•	•	2	do	
50	0 164	1	•	•	•	•	•	•	2	do	
51	0 760	1	•	•	•	•	315	18	45, flat	do	rock, loose
52	0 627	1	80	12	6 6	4 4	•	•	flat	do	
53	0 546	1	•	•	•	•	•	•	do	do	
54	0 400	1	•	•	6	4	•	•	do	do	
55	0 666	1	•	•	•	•	•	•	do	do	
56	0 870	1	•	•	6	4	•	•	do	do	
57	0 1700	1	80	13	•	•	•	•	17, flat, 10, 28	do	
58	0 149	1	•	•	•	•	•	•	28	do	loose rock
59	0 150	1	•	•	•	•	•	•	do	do	do
60	0 140	1	•	•	•	•	•	•	do	do	do
61	0 190	1	•	•	•	•	•	•	do	do	do
62	1 464	1	75 75	10 18	8	4	•	•	flat, 17, flat	do	rock and loose r.
63	0 217	1	•	•	•	•	•	•	27	do	
64	0 206	1	•	•	6	4	•	•	do	do	
65	0 343	1	•	•	6	4	•	•	flat	do	
66	0 360	1	•	•	•	•	•	•	3	do	
67	0 286	1	•	•	6	4	•	•	3	do	
68	0 264	1	•	•	6	4	•	•	3	do	
69	0 156	1	•	•	•	•	•	•	3	do	
70	0 989	1	•	•	•	•	390	17	flat, 48, flat	do	
71	0 1254	2	•	•	6	4	175	15	19, flat, 50	do	
72	0 1024	1	•	•	6	4	220	15	flat, 50, flat	do	rock
73	0 76	1 of	12 feet.	•	•	•	•	•	flat	do	

APPENDIX,

CONTAINING REPORTS FROM

LIEUTENANTS COOK AND HAZZARD,

ILLUSTRATIVE OF THE LOCATION OF THE

JAMES AND KENHAWA CANAL:

With Reports from Lieutenants Dillahunty and Fessenden, on the

SUPPLY OF WATER.

GEORGETOWN, D. C., *March* 10, 1828.

SIR: I herewith submit to you the results of those operations which, in compliance with your instructions of May 31, 1827, occupied the party under my command until those instructions were fulfilled.

They relate to the location of a line of canal from Covington, on Jackson's river, to the Greenbrier river, by the route designated in your instructions to me; as well as the location of every work connected with it, such as feeders, reservoirs, dams, &c.

Dividing the line of canal into three parts, of which the first includes the summit level, the second the portion east of it, and the third the descent to the Greenbrier river; I proceed to enumerate the details of each subdivision.

First Subdivision.—This includes a tunnel of 2 miles and 1,120 yards: two cuts of 50 feet each in depth, and two basins: together constituting the summit level, which comprises 4 miles and 789 yards. Its elevation is 694 feet above the base-mark. Further details in relation to this subdivision are omitted, because they have already been furnished you.

Second Subdivision.—To avoid the constant repetition of facts which so frequently recur, a table has been formed, to present, at one view, the details belonging to each level of this subdivision. To render it entirely intelligible, by the first level is meant that to which we descend from the summit level by the first lock; the number of locks uniting adjacent levels, refer to the number between each level and the one preceding: the length of level is made to include the space occu-

pied by the locks uniting it with the adjacent level. The length and height of aqueducts and culverts are in *feet;* length of walling in yards, and the height in feet above the bottom of the stream which it rests in.

From the foregoing table it may seem that some objectionable features attend the location of the canal; such as the occurrence of contiguous locks in five places, the crossing of Fork Run and Dunlap's creek by aqueducts, and the deep cutting in the 62d level. The reasons which influenced me in each instance will therefore be detailed. The levels along Fork run, from the descent of its valley, necessarily had to be very short; the length of the first level was greater than could have been the average by single locks, and, to avoid contiguous locks, on that account alone, we should have terminated it. But a single lock would have brought the next level in contact with unfavorable ground, necessitating either a circuitous route around a ravine, or an embankment across it; and, to diminish the difficulty, we descended at once by two locks.

At the end of the third level, the same reasons for five contiguous locks obtained, but to a greater degree; the ground was exceedingly steep, at the elevation at which, we were above the stream, and a wider and deeper ravine was before us.

The seventh level was terminated by two contiguous locks, that the eighth level might occupy the most favorable ground; and the tenth level was terminated by four contiguous locks, to avoid a high and precipitous cliff of sandstone.

Thus far, the left shore was the preferable one; but thence, to the mouth of Fork Run, the right was decidedly better, because of the frequent occurrence, on the left shore, of steep and rocky ground. We, therefore, on arriving at the end of the tenth level, descended, in order to cross as soon as possible; and, to do so with the shortest and lowest aqueduct, we resorted to two locks.

In the valley of Dunlap's creek, the descent from an upper to a lower level, is only in three places effected by two contiguous locks; in the two first cases, it was to shorten the distance, to avoid very steep ground, and to take advantage of very favorable flats: in the last case, it was to diminish the height of walling, necessary to pass the cliff which occurs in the seventy-first level.

The reasons for crossing Fork Run in the nineteenth level, have been already given; in the second instance, near the mouth, it was crossed to save the distance to a favorable point for crossing Dunlap's creek, above the mouth of Fork Run; to say nothing of the ground on the left shore of Dunlap's creek, being decidedly preferable to that on the right, for nearly two miles.

Dunlap's creek was then crossed, because the expense of crossing Brush creek, Lick creek, and sundry smaller runs, which enter on the left, would, in itself, have been more than the expense of crossing and even recrossing Dunlap's creek; and, besides, the ground on the right, for more than five miles, was known to be much better than that on the left.

The canal, subsequently, crosses Dunlap's creek four times, in its progress to the mouth of the creek. The high and extensive cliffs which occur on the right shore, between the fifth and seventh miles, it was thought entitled the left shore to the preference during that

distance; but the entrance of Ogley's creek, just below the fifth mile, and the continuance of very steep and rocky ground on the left, again renders it expedient to gain the right shore.

The two last crossings of the creek are incurred, rather than wind around the bend of the stream, on the right of which there is a deep ravine, and very steep and rocky ground; and as, agreeably to your instructions, the canal was, if practicable, to follow nearly the direction of the turnpike beyond that bend, one crossing, to avoid the rocky ground alluded to, necessitated another to conform to your instructions; since it was found practicable, and altogether more expedient, to follow the direction of the turnpike, than the very circuitous course of the creek. In evidence of this fact, the alternative which is preferred, of crossing in the depression through which the turnpike is located, instead of following the valley of Dunlap's creek, saves 1,033 yards of canal, along very unfavorable ground; at the expense, however, of the deep cut in the sixty-second level.

As to the termination of this subdivision, you remark in your instructions to me, "since it may reasonably be expected, that, if ever a canal be made, across the Alleghany mountain, to James' river, by the route to be surveyed, it would be continued down the river, or the navigation of the river would be so far improved, as to admit the passage of boats, such as would be adapted to the canal: you will, to provide for either contingency, so conclude your survey on reaching James' river, that the length and height of an aqueduct to reach Covington may be determined (as, in the event of a continuation of the canal, it is through that town that the chief engineer of Virginia has recommended its location): besides so locating it, that, in the event of its termination on this side, and the improvement of the navigation of the river by locks and dams, the lockage, &c. may be known to a basin on such a level, as would be formed by the construction of a dam of some moderate elevation."

The location exhibited by the profile of the canal refers to the latter supposition, and the descent from the last level to the surface of a basin, formed by a dam 8 feet high, 217 yards below the mouth of Dunlap's creek, is supposed to be effected by a lock of twelve feet lift; the length of the dam is 300 feet.

On the supposition of an aqueduct to cross to the town of Covington, in order to admit the requisite thickness to the arches, and be beyond the reach of freshets, (which rise from five to ten feet) the 71st level should be continued across the river; the length of that level would be one mile and 835 yards, including an aqueduct 300 feet long and 21 feet high, counting from the bottom of the stream.

The heights of freshets in Dunlap's creek vary, of course, with the fall and width of the stream, but they may be said to rise from five to seven feet, at most. The general depth of the stream is so trifling that only the low water mark has been represented on the profile: the height of aqueducts, walling, &c. is, however, counted from the bottom of the stream.

On reaching the valley of Dunlap's creek those considerations ob-

tained which you directed in reference to the introduction of a supply of water from Dunlap's creek. Without "the risque of inundation from freshets," the canal was dropped, "so as to require but a short feeder from a suitable site for a dam of moderate elevation." The section of the dam, on an enlarged scale, is given on the map; the length of the feeder is but 610 yards.

Third Subdivision: from the western end of the summit level to Bench mark, on the Greenbrier river. To this subdivision there is a table annexed, to comprehend precisely such facts as are contained in the table connected with the 2d subdivision.

No. of level.	Length of level.		No. of locks.	Aqueducts.		Culverts.		Walling.		Slope of ground transverse to level.	Nature of Excavation.	
	M.	Yds.		L.	H.	L.	H.	L.	H.		Soil.	Rock.
1	0	180	1	0	0	0	0	0	0	Flat	Sand & clay	Loose rock,
2	•	167	1	•	•	6	4	•	•	do	do	do
3	•	693	1	•	•	6	4	•	•	do	do	
4	•	173	1	•	•		•	•	•	do	do	
5	•	167	1	•	•		•	•	•	do	do	
6	•	825	1	45	•	6	4	•	•	do 17° 30′ flat	do	
7	•	330	1	•	•	6	4	•	•	Flat	do	
8	•	166	1	•	•	•	•	•	•	do	do	
9	•	433	1	•	•	•	•	•	•	do	do	
10	•	963	1	50	•	•	•	•	•	do	do	
11	•	256	1	•	•	6	4	•	•	do	do	
12	•	227	1	•	•	6	4	•	•	do	do	
13	•	740	1	•	•	6	4	•	•	do	do	
14	•	790	1	•	•	8 6 8 6	4 4 4 4	•	•	do 23° 30′	do	
15	•	360	1	•	•	•	•	•	•	23° 30′	do	
16	•	983	1	•	•	8 6	4 4	•	•	Flat	do	Loose rock.
17	•	370	1	•	•	•	•	•	•	24° flat	do	
18	•	576	1	•	•	6	4	•	•	Flat	do	
19	•	1,217	1	•	•	6 6	4 4	•	•	do 24°, 28°, 49°, 26°	do	Loose rock.
20	•	164	1	•	•	•	•	•	•	45°, 27°	do	
21	•	466	1	•	•	•	•	107	15	27°, 35°, 50°	do	Loose rock.
22	•	406	1	•	•	•	•	•	•	35°, flat	do	
23	•	633	1	•	•	•	•	•	•	35° near flat	do	Rock. Loose
24	•	743	1	•	•	•	•	•	•	do	do	[rock.
25	•	710	1	•	•	6	4	•	•	Flat 25°	do	
26	•	227	1	•	•	6	4	•	•	Flat	do	
27	•	1,270	1	•	•	•	•	125	19	do 25°, 20°, 7°, 25°	do	Earth.

The foregoing table, with the map and profile showing the location, renders it unnecessary to dwell long on this subdivision.

The reasons for first crossing the creek, when it had been determined to cross the Greenbrier river from the right bank of Howard's creek, were simply because the distance was diminished, and more fa-

vorable ground obtained on the left side; and had we not considered these, and remained on the right shore, our line would have been obliged to cross the Middle and North Forks of Howard's creek.

In the 9th and 10th levels the canal four times crossed a channel occupied by a part of the stream in time of freshets; but the stream may easily be confined to the main channel by a short dyke, and, therefore, it was not considered an objection to the location.

We recrossed the creek in the 10th level, for similar reasons: that is, to shorten the distance, &c. &c.; because, as we just now observed, the Greenbrier was to be crossed above the mouth of Howard's creek.

In the 18th level we unavoidably cross the turnpike, and it may be as well to remark that the transverse slope along the 19th level, although represented very steep, is terminated by a *flat*, not more than about 15 feet above the canal; and the cutting represented at the end of the level, is the height of a point of bottom land which we cross, because of the precipitous slope of the ground near the creek.

The walling is nowhere very considerable, and, where it has occurred, it was unavoidable.

In general it may be remarked that the canal occupies very favorable ground throughout this subdivision.

On arriving at the Bench mark, designated as the termination of this subdivision, and which is three feet below the bottom of the canal at the last level, a feeder was run up the river, on the supposition that an additional supply of water might be required. This it was found can be accomplished by a feeder 1,260 yards long, through the most favorable cutting, and a dam across the Greenbrier of 108 yards in length, and 13 feet high.

The feeder intended to introduce a supply from Greenbrier river into the canal, was located from the western end of the summit level, at an inclination of six inches per mile, until it intersects the Greenbrier river, or rather, until a dam five feet high was required to turn the water into the feeder. The length of the feeder by the route surveyed is 31 miles 130 yards, but, as it includes a tunnel of 5 miles and 200 yards, through the spur of the Alleghany mountain, which divides Howard's from Anthony's creek, our reasons for not surveying the route, also, *around* that spur, as you directed, will be given.

We shall divide the feeder into such portions that the first and third will include the parts which would be common to both routes; and the second portion, including the tunnel, will then compare directly with that part around the spur, from the end of the first to the beginning of the third part.

The first section pursues a level along pretty favorable ground, with the exception of two or three places where deep cuts for short distances must be encountered from the summit level to within but a short distance of the tunnel, and includes 4 miles and 396 yards.

The second section continues on a level but 100 yards, when 1,497 yards are occupied by the two cuts, which are supposed to terminate at 35 feet depth at either end of the tunnel; that is, the cut on the

southern side is 1,187 yards long, the tunnel 5 miles 200 yards, and the northern cut 310 yards long: the remainder of this section extends but 740 yards further to the aqueduct over Anthony's creek; making the length of the second section 6 miles 747 yards.

Now suppose, instead of tunnelling through this spur of the mountain, we follow the level, and see what objections there are to this location.

From the end of the first section, the level was continued with the intention to pursue it until we should arrive, as we did by the route through the spur, at the first favorable point for crossing Anthony's creek; but an experiment of but 10 miles over what we knew was a fair specimen of the remainder, induced us to suppose that, had you been present, you would have considered it, as we did, useless to proceed farther. The spur is indented on both sides by innumerable ravines, bounding the small branches tributary to Howard's creek or the Greenbrier river; and as a proof of the great variation from any thing like a tolerably direct course, necessitated by those ravines—while, by the route of the feeder, following the proper level or inclination, the distance is 10 miles; between the same points, by the road through the valley, the distance is but 5 miles.

We know by former surveys of last year, through the valleys of Howard's creek, the Greenbrier river, and Anthony's creek, from the point where we terminated our experiment to the point at which we should be obliged to ascend Anthony's creek to cross it, the distance could not be less than 21 miles. But these 21 miles pass over ground no more favorable, than was that which we had found to double the distance beyond what, by the same standard, without an actual location, we should have considered it. We might, therefore, with little risk of magnifying the length of feeder, by this route, add at least one-third to the 21 miles, and thus make the saving of distance, by the tunnel, 32 miles! This excessive length, however, would not alone have deterred us; but knowing, as we did, that, almost throughout these 32 miles, the feeder would pass over very steep ground, varying from 25° to 45°, we concluded the losses of such a feeder, so situated, would certainly leave a supply altogether inadequate to the wants of the canal, or in fact we concluded the other was the only practicable route. It was this conclusion which determined us to improve the means at our disposal, in the execution of surveys, which it was known to be desirable, if possible, to finish before the close of the season.

The 3d section includes the remainder of the feeder. It begins with the aqueduct across Anthony's creek, which is 40 feet high and 120 yards long. Different experiments were made to ascertain the most favorable place for crossing this creek at a less elevation above its bed; in one case, with an aqueduct of 32 feet, and 170 yards long, it increases the length of the feeder one mile; and in another, still higher up, with an aqueduct 20 feet high and 133 yards long, the distance was increased to 3 miles 342 yards. The site at last adopted was that at the point lowest down the creek, being the best that could be found.

At 487 yards beyond the aqueduct, we arrive at the end of the 11th mile from the summit level, and all that relates to the remaining part of the feeder will be found contained in the following table :

TABLE

No. of miles.	Tunnel's length.		Aqueducts.		Culverts.		Walling.		Slope of ground transverse to feeder.	Nature of excavation.	
	MILES.	YARDS.	LENGTH.	HEIGHT.	LENGTH.	HEIGHT.	LENGTH.	HEIGHT.	DEGREES.	SOIL.	ROCK.
12	.	.	.	.	.	.	.	.	28, 35, 26, 34	Clay	Loose rock.
13	1	215	.	.	6	4	.	.	34, 30, 12, 30	do	do
14	.	.	.	.	6 8	4 4	.	.	30, 26, 20, 34, 19	do	do
15	.	.	.	.	.	.	.	.	19, 30, 42, 30, 20, 42, 60, 28	do	do
16	.	.	.	.	6	4	.	.	28, 34	do	do
17	1	190	.	.	.	.	.	.	34, 40, 33, 40, 34	do	do
18	.	.	.	.	6 6	4 4	.	.	34, 35, 45	do	Rock and loose rock.
19	.	.	.	.	6 6	4 4	.	.	45, 35, 50, 35, 30, 35	do	do
20	.	.	.	.	6 6	4 4	300	30	41, 43, 33, 44, 80, 31, 43	do	do
21	.	.	.	.	6 6 6	4 4 4	260	10	43, 31, 80, 31, 34	do	do
22	.	.	.	.	6 6 6	4 4 4	.	.	34, 25	do	
23	.	.	.	.	6	4	.	.	25, 38, 23	do	Rock and loose rock.
24	.	.	.	.	10	6	.	.	23, 0, 23, 0, 32	do	Loose rock.
25	.	.	.	.	6 6 6	4 4 4	.	.	32, 38, 21	do	do
26	.	.	.	.	6 6	4 4	.	.	21, 58, 40, 50, 45, 40, 35, 30	do	do
27	.	.	.	.	10 6 6 6	6 4 4 4	.	.	30, 26, 2, 28	do	do
28	.	.	.	.	.	.	.	.	28, 26, 43, 35, 28, 4, 2	do	do
29	.	.	.	.	6	4	.	.	5, 7, 45	do	Rock and loose rock.
30	.	.	.	.	6	4	.	.	45, 50, 30, 35, 40, 35	do	do
31	.	.	.	.	6	4	.	.	3, 5, flat.	do	Loose rock.

A reference to the foregoing table shows, as the most unfavorable feature of that part of the feeder between Anthony's creek and its termination, the steep slope along which it necessarily is located; nor did it seem but that this difficulty would be rather increased than diminished by keeping a higher level. The two tunnels which occur in the 13th and 17th miles, are particularly recommended, in preference to the circuitous course we should pursue in following the level around those points through which we tunnel. For omitting any cutting at either end of those tunnels, in the one case, while the distance through is but 21 yards, the distance round is 2 miles 1,000 yards, over very rocky and precipitous ground; and, in the second case, the tunnel is but 190 yards, and the distance round, 1 mile 738 yards, over very unfavorable ground. It will be seen that *limestone* is but very seldom crossed by the feeder; generally speaking, a compact sandstone is found: rock excavation will occur in but few places: loose rocks, however, are along a great part of the line, beneath which there is a clayey and gravelly soil. When walling is mentioned, it is supposed necessary on account of the perpendicular cliffs; it, however, may prove better to blast the rocks in such places, so as to obtain sufficient width for the feeder without walling.

The dimensions of a dam, sufficiently high to turn the water into the feeder, will be seen better from the map; its *greatest* height, for it crosses an island, is 5 feet, and its length is 120 yards, including 30 yards for the width of the island. The position of the dam, for the reservoir to be formed, was chosen 285 yards above the low dam just spoken of, where the valley is very narrow, and the sides composed of rock. It might be raised to almost any height, and the relative lengths of dams of 30, 50, 60, and 70 feet high, are as follows:

Dam 30 feet high;	length at bottom	70 yards;	ditto at top,	132 yards.
50	"	70	"	195
60	"	70	"	212
70	"	70	"	228

The area and prism of each are given below.

Dam 30 feet high,	area	623,155 sq. yards;	prism	2,596,666 cub. yds.
50	"	1,278,400	"	8,578,148
60	"	1,737,162	"	14,000,000
70	"	2,191,046	"	21,000,000

The site of the dam selected the first year, in making the experimental surveys, was higher up the river, (720 feet above the base mark,) but it would overflow a much greater area in proportion to the cubic contents of the reservoir.

In every case, however, where there was occasion for the discretionary exercise of judgment in the execution of the duties assigned to Lieut. Fessenden and myself, the alternative to the course adopted by us was never rejected without our concurrent opinion that its comparative advantages could not bring it hereafter in competition.

A report of the other objects, (the rail road from Covington to the

Greenbrier river, and the connexion of the Roanoke and Kenhawa,) which subsequently occupied the party under me, is delayed until the drawings shall be more advanced.

I am, sir, very respectfully,
Your obedient servant,

WM. COOK,
Lt. U. S. Artillery on Topographical duty.

To Capt. WM. G. MCNEILL,
U. S. Top. Engineers, Georgetown, D. C.

GEORGETOWN, *March 20th*, 1828.

To Capt. W. G. McNEILL,

SIR: By the arrangements of the duties of the field for the season, the party destined to examine and locate a line of canal or rail-way from the mouth of Howard's creek, down the Greenbrier and Kenhawa rivers, to the foot of the Great Falls of Kenhawa, having been placed under my direction, I have now the honor of submitting a report upon the operations which occupied me during the Summer.

Early in the season, the levelling and survey commenced at the mouth of Howard's creek, and was continued, without intermission, down Greenbrier river to its intersection with Kenhawa or New river, and from thence to the foot of the Great Falls.

Returning to the mouth of Greenbrier river, a line of canal was examined from thence to the mouth of Little river. This is regarded as a portion of the Roanoke and Kenhawa Canal.

In describing the line as located down Greenbrier and Kenhawa rivers three divisions are made.

1st. From the mouth of Howard's creek to the mouth of Greenbrier river.

2d. From the mouth of Greenbrier river to Bowyer's Ferry, (on Kenhawa.)

3d. From Bowyer's ferry to the foot of the Great Falls.

First Subdivision.

Greenbrier river presents those characteristics which are peculiar to streams having their principal sources in the elevated regions of the Alleghany Mountains. In pursuing and forcing its circuitous passage through the many ridges of mountains that are intersected, it is frequently confined within very narrow limits. And, in such cases, it is invariably bounded by steep, rugged, and often, precipitous banks. At other points, the hills gradually recede from the river, and rich flats appear, which offer every facility for the construction of works of art.

To obtain, minutely, every feature of the valley, and thereby ensure a judicious selection of that side along which a line of canal might be most advantageously located, it was thought expedient to examine carefully both banks of the river. From the facts thus accurately developed, it will be seen that the right bank is decidedly to be preferred, both from its features being generally more favorable, and from its southern exposure.

In many instances where bluffs are met with on one bank, more favorable ground might be found on the other.

But as the river is remarkably serpentine in its course, and cliffs occur at every bend—generally on the concave side—little or no advantage, in any one instance, would be gained by crossing.

The first level of the first subdivision commences on the right bank of the river, at the point (*a*) on the map, 16 feet above low water mark.

The space, 350 yards, included between this point and the termination on the left bank of the canal line down Howard's creek, is occupied by two locks, an aqueduct, and a small portion of canal.

The highest freshets on Greenbrier, average from 9 to 13 feet; in one or two instances, it has been known to exceed 15 feet: but this rarely occurs.

In order that the aqueduct may be placed entirely beyond the reach of the highest freshets, and the quantity of drift wood and ice which is brought down during the Winter, the water line is supposed 33 feet above low-water mark. The length of the aqueduct is 167 yards.

To descend from this level to the level of the first section, two locks of 8½ feet lift are required.

A supply of water taken from the Greenbrier river at a suitable point above, may be received at the commencement of the first level, under the most favorable circumstances.

In order to avoid a tedious repetition of the same facts, which continually recur, a table is attached, exhibiting the length of each level, the number of culverts required, the extent and height of walls, and the general character of the ground.

As far as it has been practicable, the line of canal has been located at the foot of the hill slope, about fifteen feet above the surface of the water. This position is recommended by the greater uniformity which it offers in excavation, and the greater facility with which any given level may be retained.

From the first to the end of the fifth level, no material difficulty is met with. The line is traced alternately through flats generally narrow, but wide enough for all practical purposes, and, along the river bank, often rocky and steep. The streams which are crossed are generally small mountain drains, which yield, during the Summer months, little or no water. The quantity, however, of stone and gravel, which is brought down by the current after heavy rains, renders it advisable, in most cases, to pass them under the canal through small culverts.

At the beginning of the sixth level, the line intersects rugged cliffs of limestone; to sustain the level of the canal along which, a wall, 863 yards in length, and 20 feet high, is required. Its construction is facilitated by the suitableness of the stone on the spot, and the ease with which its base may be placed below low water mark. The water along the right bank, though rapid, is generally shallow. From hence to the end of the seventh level, the ground is quite favorable.

In the eighth level, perpendicular cliffs of limestone again occur. The water at the base of these cliffs is deep and rapid. Near the end of this level, the line crosses Mill Creek, by means of an aqueduct,

100 feet in length, and 17 feet above the water. This stream is remarkable from the singular fact of its disappearing entirely nine or ten miles from its mouth, and, after flowing in a subterraneous channel through this distance, it suddenly gushes up in a ravine, at the foot of high perpendicular cliffs, and soon after puts in operation a mill, which is kept in motion by it throughout the dryest seasons.

A short distance below the mouth of Mill creek, this level is again embarrassed by cliffs of limestone, requiring a wall. Opposite this point, a long rapid commences, and a suitable point may be found for a dam; one eight or nine feet high, and a feeder 946 yards in length, would furnish a fresh supply of water at the commencement of the tenth level. Early in this level, vertical cliffs of limestone are met with, which will require a strong wall, having its base generally beneath low water mark; water along the base deep and rapid.

From hence, for some distance, the ground is favorable. Towards the end of the level, the line intersects Muddy creek mountain, along the declivity of which the canal necessarily occupies very unfavorable ground. The general slope averages 18 degrees, and is covered for the most part, with fragments of sandstone and conglomerate rock.

About the beginning of the 14th level, the mountain recedes from the river, and the line occupies a very favorable flat, until it intersects Muddy creek. This creek is crossed by a small aqueduct, fifty feet in length, and nineteen feet above the water.

The quantity of water which Muddy creek yields during the Summer months, is quite small. Should its supply, however, ever be required, it might easily be thrown into the canal by a moderate dam and a short feeder.

From hence, through the 16th, part of the 17th, 18th, and part of the 19th levels, the line is traced along a hill slope, frequently steep and rocky. Several culverts are required, and some walling, the extent of which is shewn in the table. Through the remainder of the 19th level, the nature of the soil admits of easy excavation.

Through the 20th and part of the 21st level, the line occupies a very unfavorable position along a steep and rocky hill slope. From B. M. No. 20 to the end of the last level, with the exception of a straight wall along cliffs of red stand stone, the ground is generally quite favorable.

In the 22d level, Hunger's creek is crossed by an aqueduct, 50 feet in length and 17.5 feet in height, with an embankment at either extremity of 50 feet. This stream discharges a quantity of water in wet seasons; but, during the Summer months, it nearly goes dry. The deep cutting along this level is very considerable, owing to the general steepness of the hill slope along which it is located. Towards the end of this level, the river suddenly turns from a southeasterly to a northwesterly direction, forming thereby "*Stricker's neck.*" On the east side of this bend, cliffs of compact sandstone rise vertically from the water. This point presents a greater obstacle than we have yet encountered. The most unfavorable portion ex-

tends 266 yards; in this distance the river descends 10 feet, and the whole course of an impetuous current is concentrated at this point. The base of the wall required here must, unavoidably, be placed beneath low water mark, in deep and rapid water; and should be formed of the strongest materials, to resist the powerful pressure to which it will be exposed during a freshet.

No opportunity is offered of avoiding this difficulty by crossing the river, as cliffs of an equally unfavorable nature present themselves on the left bank.

The profile is the development of the line around this point. The distance, however, may be lessened more than half a mile, and this obstacle avoided, by tunnelling 133 yards through this neck, or by a deep cut 76 feet. The point alluded to is contained between the letters *x* and *y*, on the map and profile.

Through the next five, and part of the sixth levels, the canal must also be supported, in a great measure, by a strong wall, having its base frequently beneath low water mark.

From the middle of the 28th to the 35th level, the ground is generally favorable, with the exception of one or two points, at which the hill slope becomes steep and rocky. In this distance, numerous small streams are crossed, which will require, for the reasons given above, small culverts.

About the middle of the 35th level, rugged cliffs of sandstone are encountered. The river here is wide and shallow, with little fall. About the beginning of the 36th level, the line gradually curves along the base of the hill, and finally gains the wide valley of Kenhawa river. The first subdivision is supposed to end at B. M. No. 28, near the commencement of the 36th level, and opposite the mouth of Greenbrier river.

Length of the first division, 48 miles 1,561 yards.

Fall in the river, 287.520 feet.

Second Subdivision.—The valley of Kenhawa river presents, in a great measure, the same characteristics as that of Greenbrier river. Probably there is not another stream in the country, of equal size, which furnishes less bottom land along its banks, and which receives so few tributary streams of any size. The flats which are found, are generally so narrow, and occur so seldom, that the valley is, comparatively, a perfect wilderness. The numerous rapids and falls which are met in nearly every mile, form a striking feature of this river. The bed of the stream being very wide, and the water allowed, in most cases, to flow off freely, the freshets seldom exceed thirteen feet.

Although the soil of the flats is generally light and sandy, the hill slopes are usually covered with a thick growth of fine timber, such as the poplar, the beech, maple, white and red oak, and some pine trees.

The numbers of the levels are supposed to continue from the commencement of the first division.

From the commencement, then, of this division, to the end of the thirty-seventh level, the line passes through a sandy flat, offering but

little impediments. Through the next two levels, the declivity of the hill being steep and rocky, some embankment and walling is required; the extent and height of each is exhibited in the table.

Opposite the last level, the stream descends, in a few yards, thirteen feet, forming what is called "Tug Falls." The river at the head of this fall is rather wide; in every other respect, it presents a very favorable site for a dam. From hence, through the next five levels, the line meets with no obstructions. In the 42d level "*Buffalo Falls*" is passed. The river is here 298 yards in width, and descends nine feet over a ledge of rocks extending from bank to bank. This is a more favorable point for furnishing the canal with a new supply of water than the one noticed above. A dam, eight or nine feet high, and a feeder, less than half a mile in length, would effect this object. In the 45th level, the line intersects the cliffs just above "*Richmond's Falls.*" This fall is a very prominent feature of the river, and the obstacles here, on the right bank, are of the most serious nature. The river descends perpendicularly over a ledge of rocks 23 feet high, and is bounded on either side by high vertical cliffs of compact sandstone. On the right bank, the cliffs commence some yards above the falls, and extend through the 46th and part of the 47th level; in all which distance, the bed of the canal must necessarily be upheld by a high and strong wall.

On the left bank, the same rude cliffs extend for some distance above. Immediately however, at the falls, a small flat occurs, which offers greater facilities for the construction of locks, &c. At the termination of this flat, the bluffs again present their hideous front, and the left bank then becomes as unfavorable as the opposite one. Hence, the idea of crossing the river to avoid the great difficulty immediately at the falls, is precluded by the simple fact that the obstacles on the left bank, both above and below, are equally great. Through the remainder of the 47th level, the line occupies a narrow sandy flat. For the next mile and a half in the 48th level, the hill slope is steep and rocky; this is again succeeded by a favorable flat, which continues to the end. In crossing the valley of Meadow river, the embankment is greatly increased, owing to the necessity of retaining the level high enough to place the canal above the reach of the high freshets to which this small stream is subjected, as indicated by the quantity of drift-wood collected on the flat at its mouth. Aqueduct 33 yards in length and 14 feet high. Through the next nine levels, the canal is generally located along sloping ground, varying from two to twenty-three degrees. In two instances some embankment and walling is required.

In the 59th level Laurel creek is passed. About a quarter of a mile above the mouth, this creek forks, and discharges its water into the Kenhawa, through three different channels. A small dam at the forks would throw the water into one channel, and save the expense of two culverts. This level, after passing through a sandy flat, encounters a very rugged hill-slope, along which a strong wall must be constructed. Owing to the sudden bend which the river here makes, the right bank is exposed to the full force, during high tides, of an

impetuous current. Through the remainder of this level and the next, the ground is more favorable, sloping from one to ten degrees. From hence to the end of the 71st level, the canal is located, for the most part, along a steep and rocky hill-slope. The degrees of declivity, given on the profile, along each level, will show, in each case, the extent of deep cutting. The table will also exhibit the length and height of each portion of walling. Opposite the end of the 65th level, the river descends eleven feet in a few yards, and a favorable site may be found for a dam. To receive this fresh supply of water, the level of the canal is lowered by two locks, with a basin intervening, of 171 yards. Owing to the bed of the stream being here very much contracted, the height of freshets is unusually great. The wall, therefore, required to support the bed of the canal along this portion of the line, must be at least twenty-seven feet high, and calculated to resist the pressure of the immense body of water which rushes by during high tides.

From the 72d level to *Bowyer's Ferry*, the ground is generally unfavorable. In a few instances, the line passes through narrow flats, but generally along the hill-slope, which is frequently steep and rocky. Near the beginning of the 84th level, a suitable site occurs for the erection of a dam. A fresh supply of water is thought of thus early, from the circumstance that no convenient site for a dam is found between this point and the end of the line; and the canal could not be lowered below this, without materially jeopardizing its safety. The second subdivision is supposed to end at Bowyer's Ferry.

Length of this division, 45 miles 901 yards.

Total fall in the river, 399.415 feet.

Third Subdivision.—From Bowyer's Ferry to within two miles of the Great Falls, the valley of Kenhawa presents a novel and frightful appearance, and the obstacles that are met with decidedly more formidable than any that have even yet been encountered and overcome. The river here breaks through Sewell mountain, and is confined throughout within narrow limits; bounded by rugged banks and precipitous cliffs, rising many hundred feet above the surface of the water.

Immense masses of rocks, which have been ejected from the cliffs near the brow of the mountain, cover the lower slope, on both sides of the valley—giving to the whole a most appalling appearance. In many instances, these huge fragments have been precipitated entirely across the bed of the stream. In such places, the river, when agitated and swollen by heavy rains—the current being obstructed in its course—frequently rises from 35 to 50 feet above its usual height.

Numerous rapids and falls occur, over which the water rushes with deafening impetuosity.

From this feint account of the general character of this portion of the route, it will immediately be seen that the bed of a canal must unavoidably be supported throughout the whole distance by a high wall, capable of resisting the immense pressure to which it must necessarily be exposed, from the impinging of this furious current.

There is, generally, sufficient space (with the exception of three or four points noticed in the profiles, when the cliffs rise vertically from the surface of the stream) between low water mark and the bluffs, for the construction of such a wall. This space, however, is usually occupied by the immense masses of rocks alluded to above.

In all this distance, there is but one small flat: hence the want of materials on the spot, for puddling the bottom and sides of the canal, will be very seriously felt.

In making the survey, every feature of the valley was so carefully observed, that, in case a canal along this portion of the route should be thought inexpedient, from the unusually great expense which would attend its construction, a rail road might be substituted along the same line, with such alterations as might be suggested by the data now in our possession. This, however, must, hereafter, form the subject of a separate report.

About half a mile above the mouth of Gauley river, the line gains a narrow flat, along which it continues until it crosses the river by an aqueduct 23 feet above the surface of the stream, and 213 yards in length.

From hence to the Great Falls of Kenhawa, the line occupies a favorable flat.

To descend from the level of the last section to the surface of the water at the foot of the Great Falls, four locks of 9.8 feet lift are required.

A ledge of rocks, extending diagonally across the river, and over which the stream descends perpendicularly 21 feet, forms what is known as the *Great Falls* of Kenhawa. The main body of water passes through a sluice about 100 yards in width, near the left bank. The remainder of the ledge is only covered at high tide.

Just below the Falls, there is a most beautiful natural harbor, the river being here 650 yards in width, and 10 to 15 feet deep, within a few yards of the shore.

Length of 3d division - - -	21 miles 1638 yards.
Total fall in the river - - -	340.325 feet.

In conclusion, it may be proper to remark, that, hereafter, on making a more minute and protracted examination of the ground, preparatory to a permanent location, many alterations may be suggested in the position of the line of canal, and its appurtenances. But it is believed that no material difference, in the total expense of the work, will result from such partial deviations.

All which is respectfully submitted.

R. E. HAZZARD,
Lieut. U. S. Army.

No. of levels.	Length of each level.		No. of locks to the beginning of each level.	No. of aqueducts in each level.	No. of culverts in each level.	Walling		Nature of excavation.	
	Miles.	Yards.				Length.	Height.	Soil.	Rocks.
1	0	1,466	-	-	1	-	-	clay	sandstone.
2	2	-	3	-	3	-	-	sandy	
3	2	1,193	4	-	2	-	-	clay and sand	
4	2	500	5	-	5				
5	1	1,500	6	-	2	-	-	clay	
6	1	1,246	7	-	-	863	20	-	limestone and conglomerate rock.
7	1	170	8	-	1	-	-	alluvial	
8	1	1,350	9	1	1	255	23	clay	limestone—[a small aqueduct across Mill creek, 100 ft. in length, and 17 ft. high.]
9	0	763	10	-	-	-	-	gravelly	
10	2	241	11	-	1	666	18.5	stony	sandstone.
11	1	340	12	-	1	228	10		
12	0	1,438	13	-	1				
13	0	1,233	14	-	-	-	-	alluvial	
14	1	1,366	15	-	1	-	-	clay	Valley of this small stream is 60 ft. in width and 13 ft. in depth.
15	0	1,295	16	1	-	-	-	-	Aqueduct across Muddy creek, 50 ft. in length, and 19 feet above surface of the water.
16	1	853	17	-	5	756	17.5	alluvial	
17	1	966	18		1	-	-	clay	
18	1	49	19	-	-	-	-	-	slatestone. Embankment 50 yards, in length, and 15 feet high.
19	2	1,251	20	-	3	810	22	-	limestone.
20	1	104	21	-	1	-	-	alluvial	
21	3	697	22	-	-	728	20	gravelly	
22	2	524	23	1	1	408	25	-	hard sandstone.
23	0	782	24	-	-	776	26		
24	0	497	25	-	-	491	25		
25	0	1,083	26	-	-	1,077	22	-	hard sandstone.
26	1	507	27	-	-	1,286	20		
27	0	856	28	-	-	850	23		
28	1	671	29	-	2	833	25	clay	
29	0	1,479	30	-	-	-	-	gravelly	
30	0	556	31						
31	1	1,073	32	-	2	-	-	clay	rocky.
32	1	1,289	33	-	3				
33	0	1,156	34	-	2				
34	1	1,251	35	-	2				
35	1	1,596	36	-	-	1,266	23	-	sandstone.
36	1	612	37	-	-	-	-	sandy	
37	1	379	38	-	1				
38	0	677	39	-	-	528	13		
39	0	1,165	40	-	2				
40	1	612	41	-	3	500	21	sandy	sandstone.
41	0	896	42	-	1	-	-	alluvial	

No. of levels.	Length of each level.		No. of locks to the beginning of each level.	No. of aqueducts in each level.	No. of culverts in each level.	Walling.		Nature of excavation.	
	Miles.	Yards.				Length.	Height.	Soil.	Rocks.
42	1	1,378	43	-	4	-	-	sandy	
43	1	183	44	-	-	-	-	-	sandstone.
44	0	1,234	45						
45	0	779	46		-	291	18		
46	1	347	47 & 48		-	1,347	27	-	compact sandstone.—— [Two contiguous locks are required at Richmond's Falls.]
47	1	1,127	49	-	1	390	17.5	-	compact sandstone.
48	2	1,093	50	-	2	476	20	clay	
49	0	1,433	51	-	-	-	-	-	conglomerate rock.
50	0	839	52	-	-	-	-	sand	
51	0	485	53	-	1				
52	1	473	54	-	2	-	-	-	hill slope; very steep and rocky.
53	1	940	55	-	2	-	-	clay	
54	0	770	56	-	1	-	-	-	sandstone.
55	0	1,613	57	-	-	925	17.5		
56	0	967	58	-	-	-	-	sandy	
57	1	700	59	-	-	-	-		stony.
58	0	1,663	60						
59	1	1,459	61	-	3	1,213	14		
60	0	1,600	62	-	-	-	-	clay	
61	1	8	63	-	-	-	-	-	rocky.
62	1	86	84	-	-	750	24		
63	0	1,400	65						
64	0	738	66	1					
65	0	628	67	-					
66	0	171	68	-					
67	0	171	69	-	-	-	-	clay	sandstone.
68	1	839	70	-	-	1,383	26	-	red sandstone and limestone cliffs.
69	1	925	71	-	-	-	-	sandy	
70	1	1,559	72	-	1		-	sandy	
71	1	488	73	-	-	821	20	-	sandstone cliffs.
72	1	1,474	74	-	1	-	-	-	rocky.
73	0	767	75	-	1	-	-	clay	
74	1	974	76	-	1	-	-	-	along a very steep hill slope.
75	0	637	77						
76	0	1,150	78						
77	0	1,300	79	-	-	-	-	-	rocky.
78	1	1,021	80	-	2	475	25		
79	0	1,297	81	-	1				
80	0	800	82	-	1				
81	1	24	83						
82	0	843	84	-	-	-	-	clay	
83	0	747	85						

From hence, there are, in all, 42 levels and 46 locks to the surface of the water in the basin below the Great Falls; but the length of each level below Bowyer's Ferry, with such other details as are included in the tables, are reserved until the drawings shall be more advanced, on which every feature of the section will be fully exhibited. The precise termination of each level, with the most suitable position for the locks, involves considerations which are not at this time fully matured.

GEORGETOWN, D. C.

Topographical Office, March 14th, 1828.

To Capt. WM. G. M'NEILL,

SIR: I have the honor to submit the following table, exhibiting the discharge of the several streams which may be used for the supply of the proposed Roanoke and Kenhawa canal, from the mouth of Little river to the forks of the Roanoke, together with some few remarks upon those streams, and the more important mineral localities observed in the vicinity.

TABLE OF MEASUREMENTS.

Name of Stream.	Date of measurement.	Quantity in cubic ft. discharged per second.	Remarks.
South fork of Elliot's creek at the forks,	1827. August 7	5.48	
do do	do 20	9.00	Slight fresh.
do do	do 22	5.08	
do do	October 12	5.45	
North fork of Elliot's creek at the forks,	August 7	3.80	
do do	do 20	8.00	Slight fresh.
do do	do 22	4.60	
do do	October 12	4.03	
Elliot's creek, mouth,	do 22	12.02	
South fork of Roanoke, above Elliot's creek,	do do	28.00	About the minimum.
Meadow creek, near Hay's,	Septem. 21	6.44	About the minimum.
Little river, near the mouth of Meadow creek,	do 17	231.04	
Little river, 3 miles below Thompson's	do 6	161.70	Slight fresh.
Little river, at the commencement of feeder to the summit level,	do 19	118.00	
do do	October 4	97.00	
do do	do 14	111.05	

The number of mills upon these streams rendered complete accuracy unattainable.

The measurements were made under the most favorable circumstances for learning the minimum supply of the streams: for not only the quantity of rain which fell during the season was unusually small, but the intervals of its falling were so great as to give us an opportunity of observing the strength of the springs.

Little river, I uniformly learned from those who resided on its banks, had never been lower than during this season, so that its minimum supply may, with common certainty, be assumed at what it is represented in the table.

In comparison with other streams in the vicinity affording the same quantity of water, Little river is very much the shortest, and by far the greater proportion of its supply is obtained from springs, which have their rise within a few hundred yards of the river, a distance generally cleared along the whole of its length. No usual occurrence, therefore, can tend to lessen its supply materially; but should any circumstance, whatever, produce this effect, we may have resort to a reservoir, for which the valley of the river is well adapted; and a reservoir may also be formed in the valley of the south fork of Elliot's creek, near the fork, for a supply at that point.

The country is generally what is termed a limestone country, except about the upper part of Little river, where we have sandstone.

Compact limestone is the most abundant mineral production, but as to its presence, united with the oxide of manganese, a union suitable for water lime, I had not the means of ascertaining.

A fine locality of *bahrstone* was observed on the south fork of Elliot's creek, twelve miles from the Roanoke, containing a great proportion of silex, and very porous.

Iron ore was noticed on Little river, ferruginous red oxide of copper on Elliot's creek, and galena or sulphuret of lead on New river.

I am, sir, very respectfully,
Your obedient servant,

JOHN M. FESSENDEN,
2d Lt. 4th Art'y, on Topo. duty.

TOPOGRAPHICAL OFFICE,
Georgetown, D. C., Feb. 1828.

To Capt. WM. G. MCNEILL,
U. S. Top. Engineer.

SIR: Agreeably to your instructions, I have the honor to report upon the duties assigned me, whilst employed upon the surveys and examinations relating to a proposed route for a canal between the head waters of the Kenhawa and James rivers, in the State of Virginia.

During the months of August and September, 1826, and the months of May and June, 1827, I ascertained, by frequent measurements of the streams on each side of the dividing ridge, the quantity of water to be relied upon for the supply of a summit level, together with the portions of canal between the extremities of the summit level and Jackson's and Greenbrier rivers.

In the mean time, I also made an examination as to the supply of water for a canal to connect the head waters of Craig's creek, a tributary to Jackson's river, with Sinking creek, a branch of the Kenhawa.

During the latter part of the season of 1827, I reconnoitred the country in the vicinity of Huntersville, Pocahontas county, to ascertain whether or not a connection could be formed there between Jackson's and Greenbrier rivers.

Whilst in the performance of these duties, agreeably to instructions received from you, I made frequent observations relative to the *formation* of the country which I traversed.

I shall give the result of my observations in the order in which they were made: showing, in the first place, that there is a sufficient supply of water for a canal, on the route from the mouth of Dunlap's creek, at Covington, to the mouth of Howard's creek.

The following Tables contain the quantity of water discharged by the several streams to be relied upon for the supply of a canal on the different routes examined:

TABLE I—*Exhibiting the quantity of Water obtained by the measurement of the streams on the proposed route for the James river and Kenhawa Canal, in Virginia, during the months of August and September*, 1826.

Names of the Streams measured.	When measured.	Where measured.	Quantity of water pr. second, in cubic feet.
Jackson's river	Aug. 7	At Pitcher's mill, near Covington	130.5
do	7	Above the mouth of Dunlap's creek	157.2
do	24	Above Pitcher's mill	152.05
do	Sept. 6	Above the mouth of Pott's creek	156.8
do	4	Below the mouth of Dunlap's creek	246.3
Dunlap's creek	Aug. 7	Below the mouth of Augley's creek	22.6
do	7	At its mouth	25.6
do	9	Above the mouth of Snake run	19.08
do	16	At its mouth	9.43
do	17	do	10.26
do	24	do	24.0
do	Sept. 27	do	22.0
Snake run	Aug. 9	do	5.5
Augley's creek	7	do	1.12
Pott's creek	7	do	65.3
do	16	do	34.9
do	Sept 4	do	39.6
Craig's creek	Aug. 25	Below the mouth of Roaring run	157.7
do	Sept. 1	Below the mouth of John's creek	39.3
John's creek	1	At its mouth	15.4
do	1	do	16.3
do	1	do	15.85
Sinking creek	1	Below Johnson's mill	0.49
do	1	At Johnson's mill, when there is a maximum head of water at the mill	6.40
Greenbrier river	Aug. 10	Above the mouth of Howard's creek	230.7
do	20	do do do	134.7
do	20	At Bright's mill	69.44
do	21	One mile above Bright's	70.00
do	25	Above Howard's creek	148.6
do	Sept. 5	Below Howard's creek	97.0
do	6	Six miles below Anthony's creek	46.72
do	7	At Bowen's mill	46.7
do	7	Below Bowen's mill	129.0
do	7	Above McClure's mill	73.3
do	7	At McClure's mill	67.6
do	8	Above Laurel run	49.0
do	8	Above Stamping creek	42.3
do	25	Below Howard's creek	142.6
Howard's creek	Aug. 10	Below the White Sulphur springs	11.6
do	19	do do do	7.8
do	25	At its mouth	6.83
do	Sept. 5	do	12.9
do	5	do	10.9
Anthony's creek	6	do	14.3
do	Aug. 21	Six miles above its mouth	11.5
Spring creek	Sept. 7	Near its junction with Greenbrier river	9.6
Locust creek	8	Near its mouth	0.66
do	8	At a mill near its mouth	0.704
Stamping creek	9	Near its mouth	5.00
Beaver creek	9	do	2.5
Knapp's creek	14	Six miles above its mouth	41.0
Second creek	Aug. 29	Below Patton's mill	33.3
do	29	At Knox's ford	28.29
do	29	Near the Gap mills	30.09

TABLE II.—*Shewing the quantity of Water found in the streams on the proposed route for the James river and Kenhawa Canal, in Virginia, during the months of May and June*, 1827.

Names of the streams measured.	When measured.	Where measured.	Quantity of water pr. second, in cubic feet.
Jackson's river -	May 4	Below the mouth of Dunlap's creek -	350.00
do -	18	do do do -	568.78
do -	19	do do do -	607.00
do -	25	do do do -	1800.00
do -	June 5	do do do -	600.00
do -	16	do do do -	419.70
Greenbrier river -	May 9	Below the mouth of Howard's creek -	1768.00
do -	10	do do do -	1995.00
do -	16	do do do -	1970.60
do -	12	do do do -	4000.60
do -	22	do do do -	6650.00
do -	24	do do do -	2000.00
do -	25	do do do -	1500.00
do -	27	At Bowen's mill - - -	1224 00
do -	27	At McClure's mill - - -	882.00
do -	June 5	At the bridge - - -	1800.00
do -	26	Near McClure's - - -	752.30
Augley's (or Ogley's) creek -	May 1	At Callaghan's mill - - -	10.80
do -	June 16	At its mouth - - -	9.50
do -	May 21	do - - -	50.00
do -	June 26	do - - - -	60.00
Howard's creek -	May 16	do - - - -	40.40
do -	21	do - - - -	370.00
do -	24	Below Dickson's run - - -	49.30
do -	24	Near its mouth - - -	184.60
do -	25	do - - - -	180.00
do -	June 6	do - - - -	360.00
do -	7	Near Little Dickson's - - -	67.60
South fork of Howard's creek -	May 16	Near the toll gate - - -	5.57
do -	22	do - - - -	80.00
do -	24	do - - - -	30.00
do -	25	do - - - -	26.00
do -	June 19	do - - - -	27.00
Dunlap's creek -	May 17	Above Colonel Crow's - -	41.50
do -	17	Below Crow's mill - - -	52.90
do -	19	At its mouth - - - -	79.30
do -	21	Below 'Squire Bishops - - -	323.02
do -	June 5	Below Augley's creek - - -	50.00
do -	16	do - - - -	19 80
Potts' creek -	May 19	At its mouth - - - -	85.10
Mill creek -	23	do - - - -	142.72
Dickson's run -	24	Near its junction with Howard's creek	31.00
Spring creek -	27	At Burr's mill - - -	56.00
Locust creek -	27	Near its junction with Greenbrier river	84.00
Anthony's creek	June 27	One mile below Wiley's, and near the intersection of the *feeder line*, &c. -	433.10

NOTE.—All the streams mentioned in the foregoing tables, were measured by means of a *float*, with the exception of Dunlap's creek, which, on the 10th and 17th days of August, was measured by means of a *waste-weir*, or dam. At mills, the methods prescribed for measuring by means of *orifices*, have generally been adopted.

N. B.—The quantity of water given in the fourth columns of the tables, is expressed in *cubic feet per second*.

TABLE III.—*Of the quantity of Water found in the streams on a proposed route for the James river and Kenhawa Canal, in the vicinity of Huntersville, in the county of Pocahontas, Virginia, (May a d June, 1827.)*

Name of stream measured.	When measured.	Where measured.	Discharge of water in cubic feet
Greenbrier river -	May 29	Below the mouth of Knapp's creek -	2400
do -	June 2	Seven miles above the mouth of Deer creek	420
do -	10	Ten miles below mouth of Knapp's creek	432
West Fork do -	25	At its junction with East Fork, Gr. - -	777
East Fork do -	25	do do West Fork - -	220
Knapp's creek -	May 29	Near Huntersville - - - -	156 9
do -	31	Above the mouth of Sugar-tree creek -	15.0
do -	June 10	do do do - - -	78
Warm Spring run	May 30	Four miles below Warm Springs - -	28
do -	June 9	do do do - - -	14
Jackson's river -	May 30	Midway between the Warm Springs and the mouth of Little Back Creek - -	448
do -	June 9	do do do - - -	140
Big Back creek -	May 30	Above the mouth of Little Back creek -	296
do -	June 10	do do do - - -	140
Little Back creek	May 31	At its mouth - - - - -	50.9
do -	June 10	do - - - - - -	20
Sugar-tree creek	May 31	Near its mouth - - - - -	15
Sitlington's creek	31	Near where a feeder line would strike it, &c.	100
Deer creek -	June 1	Above Woodle's mill - - - -	86
do -	19	do do - - - - -	50
Camp run, a branch of Deer creek -	1	At its mouth - - - - -	11
Duncan's run do	1	do - - - - - -	10
Buffalo run do	1	do - - - - - -	10
Salisbury run do	1	do - - - - - -	11
Back creek -	24	Near McCloud's - - - - -	200
Knapp's creek -	19	Above the mouth of Sugar-tree creek -	10
Six other small runs	19	Where a feeder would strike them, &c. -	16.00

I will now point out the resources which may be relied upon to supply with water the summit level, and the portions of canal on the Covington route, between the mouths of Dunlap's creek and Howard's creek. It is known from the surveys which have been made on this route, that we must in a measure depend for a supply of water upon the following streams, viz:

Greenbrier river,	(minimum supply)	8th	September, 1826,	42.3 cubic feet.
do	(mean supply)		do	67.6
Anthony's creek	- -	6th	do	11.6
Dunlap's creek	- -	9th	do	5.5

Besides the supply from these streams, we can avail ourselves of a reservoir, which shall contain either 13,06),584.9 cubic yards, or 4 6 3.040 cubic yards, according to the height of the dam which may be constructed at the point where the feeder from Greenbrier river is taken. To show that this supply will suffice to feed the summit level, to supply its lockage, and feed, besides, the portions of canal conti-

guous to it, we have made the same suppositions with regard to this route, that the Board for Internal Improvement did with regard to the proposed route for the Chesapeake and Ohio Canal. Suppose, in the first place, the navigation to be interrupted four months in the year, viz. from the 1st of December to the 1st of April. Adopting 67.6 cubic feet per second as the mean supply of water afforded by Greenbrier river, first, in the Winter season, at the point where the feeder to the summit commences in said stream, it will be found that the larger reservoir would be filled twice during the interruption of the navigation, and the lesser reservoir would be filled in nearly one-third of the time required to fill the larger one. But 67 6 cubic feet per second, is certainly much less than the mean supply afforded by the Greenbrier river in the Winter season. (See Tables II and III) It is in fact thought to be much less than the mean supply during the season of open navigation.

So, that whilst the navigation continues open upon this last supposition, the larger reservoir would be filled, at least, every two months, and the smaller reservoir oftener than once per month, from Greenbrier river itself. Now, in order that we may see what influence evaporation, &c. may have upon this supply, let us make a computation as to the supply which may be expected from rains.

This, it will be seen, besides making up for evaporation and soakages in the reservoir, and in the feeder to the summit level, will leave a very large supply, which may go towards the feeding of the summit and portions of canal contiguous to it.

We shall take an area of fifty-five square miles, which we suppose to supply Greenbrier river with rain water. This area is chosen from an inspection of the map of this part of the country: from which we find that the sum of the lengths of the streams tributary to Greenbrier river, exceeds one hundred and ten miles; and, from a knowledge of the country, we know the width of their valleys to average more than half a mile.

We shall assume for the fall of rain on this surface, the least quantity which fell from the year 1817 to 1824, in the vicinity of Baltimore.

The least quantity fell in 1822, which was for the Fall and Winter, 16.7 inches; and for the six other months, 12.5 inches; making, for the whole year, 29.2 inches. So, it will be found, that the assumed area will receive during

The Fall and Winter, - -	78.880.384	cubic yards,
The Spring and Summer, - -	59.117.696	"
The whole year round, - -	137,998,080	"

From which it will be seen, that the first quantity would be six times as much as would be necessary to fill the larger reservoir in the Winter season; and seventeen times as much as would fill the smaller one. And that the second quantity would fill the larger reservoir more than four times in the Summer, and the lesser one, nearly thirteen times. Now, what is the evaporation, soakage, &c. compared with these quanties? Suppose the evaporation to be thirty-two inches

per annum, which are equivalent on a surface equal to one square yard, to 0.910 cubic yards. Now we will apply this, to the feeder and reservoir. The feeder, which is about 33¾ miles in length, will have a surface, say, equal to about 590,880 square yards; and, consequently, the evaporation on it would be equal to 541,300.8 cubic yards. Suppose, now, the soakage to be equal to one and a half times the evaporation, (which is, no doubt, considering the nature of the soil over which the feeder line passes, a sufficient allowance.) This last supposition gives for the evaporation and soakage together, of the feeder, 1,353,252 cubic yards. The evaporation of the reservoir, taking the larger one, whose surface would be equal to 2,508,333.3 square yards, would be equal to 2,282,583.303 cubic yards; or, the evaporation and soakage together, equal to 5,706,458.25 cubic yards: making, for both the feeder and reservoir, the evaporation and soakage together, equal to 6,059,710.25 cubic yards. Should we double the allowance above made for evaporation, &c. it would be seen, that it could not even then be compared with the quantity available from rains. It is, in fact, very trifling, even when compared with the fall of rain during the Spring and Summer months. It should also be recollected, that we have assumed for the fall of rain, the least quantity which fell in the course of a number of years, in a section of the country, where the fall is not to be compared with that in the elevated section of country which we have examined.

I think, therefore, that it would be safe to adopt the following, as the *minimum* supply of water which can *ever* be expected on the route in question—and which *will* suffice to feed the summit level, and portions of canal contiguous to it, viz:

Greenbrier river,	-	42.3	cubic feet per second,
Anthony's creek,	-	5.5	" "
Dunlap's creek,	- -	5.5	" "

And the supply of 13,060,584.9 cubic yards from the reservoir, (using the larger one.)

It will be observed, by reference to Table I, that the least quantity of water found in Anthony's creek, six miles from its mouth, and near where the feeder line strikes it, is 11.6 cubic feet per second—we have assumed less than the half of it for the minimum supply. A less quantity is also assumed for Dunlap's creek than has ever yet been found in it at any one point; one of its tributaries, Snake Run, gave, on the 9th of August, 1826, the same quantity which it will be perceived is assumed for the stream itself. And it should be recollected, that the canal line strikes the creek *some* distance below the mouth of Snake Run.

We could, no doubt, avail ourselves of several times the quantities assumed, as the discharge of these streams: for, besides the actual quantities flowing in them, we can, if necessary, have recourse to small reservoirs on both of them. And as regards Greenbrier river, it presents frequent sites for dams suitable for the formation of reservoirs; and that, should it be found necessary, one may, of almost

any height, be formed, at any point above the one chosen for the commencement of the feeder to the summit level.

If necessary, reservoirs might be formed upon several of the tributary streams of Greenbrier river, and sometimes upon streams tributary to them.

But to limit the supply to the quantity above assumed, and calculating upon an open navigation of eight months in the year, it will be found that the monthly supply (adopting the larger reservoir.) will be as follows: viz. - - 1,632,573.1 cubic yards from the Reservoir, 4,156 790.4 " from Greenbrier river, and - 1,055,980.8 " from Dunlap and Anthony's creeks; making the whole supply equal to - - 6,845.344.3 cubic yards.

This monthly supply may be disposed of, after the following manner: considering the length of the summit level, it is probable that about two hours would be required for a boat to pass from one extreme point of it to the other; that is to say, it would move at the rate of a little more than one mile and a half per hour. This would be for a single boat: But, with a view to the saving of both time and water, we will suppose the trade to be carried on by a number of boats passing and re-passing the different locks at the same time—let the number be twenty. But as a greater length of time is required for a number or train of boats to pass the summit level, than for a single one, we shall increase the time assumed for the passage of a single one, one half for a train; that is, we suppose it to take three hours for a train of 20 boats to pass from one end of the summit level to the other.

The trade from the east to the west, we suppose would be carried on in this manner. The first train of twenty boats would leave the first lock, at the commencement of the summit level, and arrive in three hours afterwards, at the lock, at the other extremity of the level, (which we shall here call the second lock,) when it would meet a second train, having passed the second lock. This second train would arrive in three hours afterwards at the first lock, and find a third train, having passed during the passage of the first and second trains, and ready to proceed towards the second lock; and which would arrive there in three hours afterwards, and find a fourth train having ascended to the summit, and ready to proceed to the first lock; and so on, until the whole five trains shall have passed the summit.

The passage of these five trains, or one hundred boats requiring fifteen hours, may be assumed as the greatest trade on this part of the canal.

It is readily seen, that this trade agrees very well with the monthly supply: for, at the rate of one hundred boats per day, three thousand might pass per month, and twenty-four thousand during the season of open navigation. And as the boats are supposed to pass the locks alternately, one lockful of water only for each boat will be required to pass the summit level. But to remove all doubts as to the adequacy of the monthly supply, we shall add half a lockful for leakage, &c.

This allowance supposing the size of the locks the same as those contemplated by the Board of Internal Improvements for the *proposed* Chesapeake and Ohio Canal, will be equal to 623 cubic yards; so that all the boats which would pass during a month, would require for lockage, 1,869.000 cubic yards of water. Which, taken from the monthly supply, leaves 4.976.344.3 cubic yards.

This residue would supply the canal from the mouth of Howard's creek, to the mouth of Dunlaps' creek, a distance of about 33 miles 737 yards, at the rate of 148,992.34 cubic yards, per mile, per *month*; or 93.1202 cubic feet per *minute*; which are equal to 1.552 cubic feet per *second*, per mile.

And for the supply of the whole distance from the mouth of Howard's creek, to the mouth of Dunlap's creek, we should have considerably more than one and a half cubic feet per second per mile, should we take into consideration the quantity which may be had from Howard's creek, some distance above its mouth. We speak now of one and a half cubic feet of water per second, exclusive of lockage, and, if you please, of evaporation, soakage, &c. It is thought, however, to be a sufficiency, absorption, evaporation, &c. included. We might assure ourselves of this fact immediately, by making a comparison between this supply and the different supplies which answer for many of the canals constructed in France and elsewhere. But I shall merely advert to the fact, that, from experiments which have been made upon the New York canal, and others which have been constructed in this country, it has been ascertained that about 100 cubic feet of water per minute per mile only, are requisite for navigating an ordinary canal in this country, *lockage* included.

Now, if we apply this to the James river and Kenhawa canal, on a distance of about 33 miles 737 yards, and deduct 1.869,000 cubic yards, which we have allowed for lockage, we shall find that there will be a much smaller quantity left, (*and which would supply the canal*) than we can calculate upon from Greenbrier river, Anthony's and Dunlap's creeks, and the reservoir which would be formed on the Greenbrier. The foregoing calculations were made from data obtained from the experimental surveys made in 1826. Subsesequent examinations develop facts which effect a slight change in them. By the recent surveys which have been made, it appears that the feeder line, from Greenbrier river to the summit level, can be shortened about two miles, making the entire length of it only 31 miles 130 yards.

The length of the summit level is 4 miles 789 yards; and the distance from its eastern extremity to the point where the canal is fed by Dunlap's creek, is 2 miles 1.718 yards. The distance from thence to the mouth of the creek, 16 miles 115 yards. The distance from the point where the feeder line strikes the summit level to the point where the canal is fed by Howard's creek is 3 miles 1,175 yards; and from thence to the mouth of the creek, 4 miles 740 yards; making the length of canal from the mouth of Howard's creek to the mouth of Dunlap's creek, about 31 miles 1,017 yards. An alteration has been made in

the situation of the dam for the reservoir on Greenbrier river. This dam, though supposed to be as high as the dam of the larger reservoir first calculated upon, is found to give a reservoir with a prism of water equal to only 8,578,148 cubic yards; but which, when compared with the former larger reservoir, is found to have a much smaller than a proportionable surface exposed to evaporation.

The surface of this reservoir is equal to 532,666 square yards, and the evaporation from it would be equal to 484,726.06 cubic yards. If to this quantity, after making a due allowance for soakage, we add the evaporation and soakage of the feeder line, and subtract the sum thereof from the quantity of water available from rains, the residue would still be more than sufficient to fill the adopted reservoir once per month. Besides, it is probable that the reservoir would be filled once per month, the year round, from Greenbrier river. The quantity (67.6 cub.) first assumed as the mean supply of the river, would fill it once in less than every forty days. So, to feed the summit level, and portions of canal between its extremities and Dunlap's and Howard's creeks, we may, with safety, calculate upon the contents of a reservoir formed in Greenbrier river, and the least quantities of water afforded by Greenbrier river, Anthony's creek, Howard's and Dunlap's creek.

The supply would be as follows: calculating upon an open navigation of eight months in the year, the reservoir formed in Greenbrier river would give a monthly supply of 1,072,268.5 cubic yards. And from Greenbrier river, containing 42.3 cubic feet per second.

Anthony's creek -	5.5	do.
Howard's creek -	6.8	do.
And Dunlap's creek	5 5	do.

We should have a monthly supply of 5,769,552.6 cubic yards. If from these supplies we subtract the lockage for 3,000 boats per month, it will be seen that the residue would feed the entire canal from the mouth of Howard's creek to the mouth of Dunlap's creek, at the rate of something like 157,517 cubic yards per mile per month, which are, exclusive of lockage, more than sufficient for that purpose, all other losses included.

The canal may be fed in this manner: From Greenbrier river, the reservoir formed in it and Anthony's creek, affording, together, a monthly supply of 5,661,068.5 cubic yards per mile. From this quantity, there will be left, after feeding the summit level, and the portion of canal between its eastern extremity and the mouth of Dunlap's creek, (a distance of about 23¼ miles) about 618,519 cubic yards per month; that is, after deducting lockage for both extremities of the summit level, and taking into consideration a monthly supply of about 528,000 cubic yards afforded by Dunlap's creek, more than 16 miles from its mouth. Now, this remaining supply of 618,519 cubic yards per mile, &c. together with a supply of 652,800 cubic yards per mile per month, from Howard's creek, more than 4 miles from its mouth, will feed the remaining portion of the canal from the western extremity of the summit level to the mouth of Howard's creek—a distance of about 8 miles.

If we found the calculations upon the least quantities of water which have yet been found to flow in the streams used on this route, *at the points where it is probable they would be brought into requisition to feed the canal*, it will be seen that the fall of rain water need not be so much relied upon. For instance, we have Greenbrier river, containing 46.72 cubic feet per second. (See Tab. I.)

Anthony's creek	11.50	cubic feet per second.
Howard's creek	6.83	do
And Dunlap's creek	9.43	do

Giving altogether a monthly supply of 7,150,080 cubic yards. If to this supply we add the monthly supply from the reservoir which we suppose filled from Greenbrier river during the interruption of the navigation, and make a deduction for lockage, there will remain a a monthly supply of 6,353,348.5 cubic yards, which would supply the canal under consideration, at the rate of 194.581.2 cubic yards per mile per month, which are, at least, more than half a cubic foot per second per mile more than is necessary for that purpose; and which, together with a small quantity of *rain water*, would supply the losses of the feeder, &c.

Before concluding, we will make one other supposition. Suppose an open navigation of nine months in the year; and suppose the feeder from Greenbrier river to the summit level, and the canal from the mouth of Howard's creek to the mouth of Dunlap's creek, to lose each its prism of water per month, by evaporation and filtrations; and allow 1,454,178.18 cubic yards for the leakage and evaporation of the reservoir, (supposing the former to be twice the latter,) and making a due allowance for lockage—we shall have, during an open navigation of nine months, all losses equal to about 32,962,494.18 cubic yards. Now, if we compare this with the fall of rain *even* during the Spring and Summer, there will remain a monthly supply of 2,906,133.53 cubic yards of water, which may go towards supplying the canal. That is to say, we should have for the supply of the canal, including running water, a monthly supply of 8,771,933.53 cubic yards, after having made good all losses; which is twice as much as is necessary. I shall finish these remarks by repeating, that, when we take into consideration the many favorable sites for dams, suitable for the formation of reservoirs on Greenbrier river and elsewhere, we can never dread an insufficiency of water for the supply of a canal on this route. In addition to this fact, the relative situation of Cheat river with regard to Greenbrier river, by which, in case of any unexpected casualty, a feeder, with a sufficient supply of water for a canal, might be brought from thence to the Greenbrier river, leaves no doubt of the practicability of a canal communication between the head waters of James river and the Kenhawa.

The next object which occupied my attention, was the examination of a proposed route for the James and Kenhawa canal, by way of one of the head branches of Craig's creek, a tributary to Jackson's river, and Sinking creek, a tributary to the Kenhawa. I deem it unnecessary to enter into a minute description of the country along this route, as I

shall be able to shew, in a very few words, that there is not a sufficient supply of water for a canal. To supply the sumit level of a canal on this route, we should have to rely almost altogether on John's creek, a branch of Craig's creek, which gave, on the 1st September, 1826, at its mouth, a discharge of water equal to only 15.4 cubic feet per second, which, is not, perhaps, the minimum supply during the driest season of the year. As regards Sinking creek, we might often, during the dry season, expect to find it, if not dry, almost so. Relying, then, principally on John's creek, we should have a monthly supply of water which would not suffice for lockage alone. Allowing the same quantity of water for lockage on this route as we did on the Covington route, we should want an additional quantity of 391,560 cubic yards per month for lockage.

The quantity of water afforded by John's creek, (15.4 cubic feet per second) and the quantity afforded by Sinking creek, (.49 cubic feet) together, equal to 15.89 cubic feet per second, would have to supply a summit level and portions of canal together, equal to at least from 30 to 36 miles. Now, at the rate of one and a half cubic feet per second, it is readily seen that the above quantity would only feed a canal something like ten miles, exclusive of lockage.

In a word, the great additional supply of water wanted for a canal by *this route* can *never* be had : for we can alone expect it from reservoirs ; and though one or two might be formed on the route, they could be but small.

A canal, by this route, even if there was a sufficient supply of water, would have nothing to recommend it : for we should certainly have a very long tunnel on it, and that, too, over an elevated summit level.

The foregoing remarks would apply equally as well to any route by the way of Potts' creek, &c.

The next examination which I made, agreeably to the instructions received from you, was of the country between the head branches of Jackson's river and Greenbrier river, in the vicinity of Huntersville, Pocahontas county.

My attention was particularly directed to the ascertaining of the fact, "whether or not Greenbrier river, near the mouth of Knapp's creek, approached sufficiently near to Jackson's river, or some of its branches ; and whether or not the dividing ridge between those streams was sufficiently depressed to admit of a connection between them by means of a canal without a tunnel." There are, it is true, several depressions in the Alleghany mountain, or dividing ridge between the Eastern and Western waters, in the county of Pocahontas. There is one seven or eight miles from Huntersville, between the head waters of Knapp's creek and Little Back creek ; and, another, still higher up, between the head waters of Sugar Tree creek, a branch of Knapp's creek, and Big Back creek, a branch of Jackson's river. But the most considerable one in the mountain is where the road from Huntersville to the Warm Springs, in Bath county, crosses it. A communication might be made between Knapp's creek

and Back creek, through this gap, perhaps without a tunnel, or, if with one, a very short one. But for a sufficient supply of water for a canal between those streams, we should have to resort to a long feeder from Greenbrier river, and one, too, perhaps, with one or two tunnels.

Table III shews the quantity of water afforded by the different streams in this section of the country at the time I made the examination of it. But we could not depend upon any thing like those quantities during the greater part of the Summer season.

From a mere examination of the table, it will be seen that, at the time the different streams were measured, there was a supply of water afforded by them more than necessary to effect the desired communication. But, having since seen many of these streams, whilst employed upon the examination of a route for the Baltimore and Ohio Rail Road, (during the dry season,) I am fearful there could not be had, at all seasons of the year, a sufficient supply of water for a canal communication by this route. But even if there could be found a sufficient supply, it would not then compare with the route from Covington to the mouth of Howard's creek, as will be plainly seen from the following facts: On this route, the length of canal would be greater, by at least one hundred miles, than by the Covington route; that is to say, the distance (following the probable direction for the location of a canal) from the Greenbrier bridge to Huntersville, on Knapp's creek, and from thence, over the dividing ridge, and down Back creek, &c. to Covington, would be at least one hundred miles, and probably more.

The fall of the ground from the western extremity of the summit level of this route, to the Greenbrier bridge, near the mouth of Howard's creek, is about 1,500 feet; so, to make a comparison between the lockage on this route and that on the Covington route, we have the amount of lockage from the western extremity of the summit level on the Covington route to the mouth of Howard's creek, equal to 224 feet: and the amount of lockage from the eastern extremity of said summit level to the mouth of Dunlap's creek, equal to 694 feet; making the amount of lockage for the entire distance from the mouth of Howard's creek to the mouth of Dunlap's creek, equal to 918 feet; consequently the fall from the eastern extremity of the Pocahontas summit, to the mouth of Dunlap's creek, is equal to 1,970 feet, making 2,552 feet more of lockage on the Pocahontas route than on the Covington route.

The great additional number of aqueducts which would be required on this route, would make the cost of its construction very great, when compared with the Covington route. In the distance from the mouth of Howard's creek to the mouth of Knapp's creek, pursuing either side of Greenbier river, it would be found necessary to cross from eight to ten of the tributary streams of the Greenbrier. And owing to the frequent sinuations in the Greenbrier river itself, it is probable that it would be found necessary to cross it four or five times, in some instances to save distance, and in others to avoid encountering

bad ground, &c. The same remarks would apply to Jackson's river. So, without a tunnel, and with a *sufficient supply of water*, I am of opinion, that the Pocahontas route could have no advantages over the Covington route.

I will now conclude by making some general remarks as to the *formation* of the country, which we have examined, for the purpose of ascertaining the practicability of a connection between Greenbrier and Jackson's river. The rocks in the vicinity of the dividing ridge between these streams, are of the transition class, and consist principally of sandstone and lime-stone. Hornstone and other rocks are sometimes met with, but in very small quantities. Of the rocks abovementioned, sandstone is, perhaps, the most predominant. Compact limestone, (*blue*,) however, occurs in considerable quantities throughout the whole district, and may be used either as a building stone, or for the purpose of furnishing *ordinary* lime. The most considerable deposite of limestone which we have seen in this section, is a zone or belt which passes from north to south through Lewisburg, Union, &c. and which we have traced from its outgoings or appearance on the surface of the earth, for the distance of from 20 to 30 miles; its width hardly ever exceeds a mile. Connected with this deposite of limestone, for a number of miles, is one of hornstone.

Limestone is found on most of the streams east and west of the dividing ridge, viz: on Jackson's river, on Craig's creek, on Dunlap's creek, and on Augley's creek. In a word, the whole country, from Covington to the Sweet Springs, abounds in limestone. It is found on Sinking creek, and on Knapp's creek; on Anthony's creek we generally find sandstone. On Greenbrier river, above the bridge, we sometimes meet with limestone, but the usual formation is of sandstone.

And it may here be remarked, that the *feeder line* from Greenbrier river to the summit level, will seldom intersect limestone formations, although we frequently find limestone in the vicinity of the Greenbrier, on either side, as high up as Huntersville, in Pocahontus.

Freestone, suitable for constructions, is found on both sides of Greenbrier river, near the bridge; of this stone, the piers of the bridge are constructed.

I examined the country particularly between Howard's creek and Crow's, on Dunlap's creek, in the direction of the proposed *tunnel* between those streams, and came to the conclusion, that, in the construction of the tunnel, for the principal part of the way through the ridge, solid sandstone would be met with. And whenever this was not the case, which would probably be in the commencement and termination of the tunnel, we should probably encounter argillaceous slate, and sandstone with a slaty structure.

The soil throughout the whole section of country examined, is generally very good; but varies in quality in a measure with the different kinds of rock met with. Limestone soil being better than sandy soil.

Coal and iron ores, are the only mineral productions discovered, worthy of much notice.

Coal has been discovered some few miles from the bridge on Greenbrier river, and will probably be found elsewhere, as we have frequently observed formations with which it is almost always associated. We have noticed the appearance of it particularly between the Greenbrier bridge and Lewisburg. We have not, however, seen any specimens of a good quality.

This section of country is, unquestionably, the repository of numerous beds or deposites of iron ore. We are assured of this fact by its appearance in several places. A considerable bed of it is found on John's creek near New Castle. It also abounds on Dunlap's creek and its branches, in the neighborhood of Covington; and will, no doubt, be frequently met with elsewhere.

The ore on Dunlap's creek is the *red oxide*, and is considered of a most excellent quality.

All of which, I have the honor respectfully to submit, &c.

JNO. N. DILLAHUNTY,
Lt. 1st Reg't Art. on Toph'l duty.